Report on priorities for an expert assessment of North Atlantic MPAs, EBSAs, and VMEs in ABNJ

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List of acronyms

ABMT – Area-Based Management Tool
ABNJ – Areas Beyond National Jurisdiction
AMO – Atlantic Multidecadal Oscillation
AMOC – Atlantic Meridional Overturning Circulation
AORA – Atlantic Ocean Research Alliance
ATLAS – A Trans-AtLantic Assessment and deep-water ecosystem-based Spatial management plan for Europe
BBNJ – Biodiversity in Areas Beyond National Jurisdiction
BD – Biodiversity
BG – Blue Growth
CBD – Convention for Biological Diversity
CC – Climate Change
CCAMLR – Commission for the Conservation of Antarctic Marine Living Resources
CEC – Commission for Environmental Cooperation
CFP – Common Fisheries Policy
CGFZ – Charlie-Gibbs Fracture Zone
CLCS – United Nations Commission on the Limits of the Continental Shelf
COP – Conference of Parties
DOALOS – UN Division for Ocean Affairs and the Law of the Sea
DSF – Deep-sea fishery
EAFM – Ecosystem Approach to Fisheries Management
EBM – Ecosystem-based management
EBSA – Ecologically or Biologically Significant Marine Areas
EC – European Commission
EEZ – Exclusive Economic Zone
EIA – Environmental Impact Assessment
ES – Ecosystem Services
EU – European Union
FAO – Food and Agriculture Organization
FC – Fisheries Commission
GC – General Council
GHG – Greenhouse Gas
GOBI – Global Ocean Biodiversity Initiative
GSL – Gulf of Saint Lawrence
IBA – Important Bird Area
ICCAT – International Commission for the Conservation of Atlantic Tunas
ICES – International Council for the Exploration of the Sea
IMO – International Maritime Organization
IMP – Integrated Maritime Policy
IPCC – Intergovernmental Panel on Climate Change
ISA – International Seabed Authority
IWC – International Whaling Commission
MARNA – Mid-Atlantic Ridge North of the Azores

MARPOL - International Convention for the Prevention of Pollution from Ships
MCS – Monitoring, control and surveillance
MGR – Marine Genetic Resource
ML-TZ – Mid-Latitude Transition Zone oceanographic region
MPA – Marine Protected Area
MSFD – Marine Strategy Framework Directive
MSP – Marine (or Maritime) Spatial Planning
NAFO – Northwest Atlantic Fisheries Organization
NAMMCO – North Atlantic Marine Mammal Commission
NAMPAN – North American Marine Protected Areas Network
NAO – North Atlantic Oscillation
NASCO – North Atlantic Salmon Conservation Organization
NE – Northeast
NEAFC – North East Atlantic Fisheries Commission
NRA – NAFO regulatory area
NW - Northwest
OECM – Other Effective area-based Conservation Measures
OSPAR – Oslo and Paris Convention
PECMAS – NEAFC's Permanent Committee on Management and Science
POC – Particulate Organic Carbon
PSSA – Particularly Sensitive Sea Area
RFMO/A – Regional Fisheries Management Organization/Arrangement
SAI – Significant adverse impact
SBSTTA – CBD's Subsidiary Body on Scientific, Technical and Technological Advice
SC – Scientific Council
SDG – Sustainable Development Goal
SGMPAN – Study Group on Designing MPA Networks in a Changing Climate
SP – Sub-polar
SP-NWA – Sub-Polar NW Atlantic oceanographic region
SSS – Sea Surface Salinity
SST – Sea Surface Temperature
ST – Sub-tropical
TAV – Tropical Atlantic Variability
UK – United Kingdom
UNCLOS – United Nations Convention on the Law of the Sea
UNFCCC – UN's Framework Convention on Climate Change
UNGA – United Nations General Assembly
USA – United States of America
VME – Vulnerable Marine Ecosystem
WG – Working Group
WGDEC – Joint NAFO/ICES Working Group on Deepwater Ecology
WGEAFM – NAFO's SC Working Group on the Ecosystem Approach to Fisheries Management
WGESA – NAFO's Working Group on Ecosystem Science and Assessment
WNA – Western North Atlantic
WP – Work package
WWF – Worldwide Fund for Nature

Executive Summary

The deep sea (> 200 m below sea level), including the deep North Atlantic, supports vitally important ecosystem services. The United Nations Convention on the Law of the Sea (UNCLOS) places an obligation on States to protect and preserve rare and fragile ecosystems. Dealing with the multiple and increasing pressures placed on the deep sea, and balancing Blue Growth against long-term sustainability, is an urgent task requiring adequate governance and management systems and thorough evaluation of cumulative impacts, grounded on sound science. The temporal stability of management measures is a key aspect of achieving this sustainability.

A task of the EU ATLAS project is to review the current and likely future status of North Atlantic Area-Based Management Tools (ABMTs) in Areas Beyond National Jurisdiction (ABNJ) informed by predicted shifts in ecosystem dynamics. The effectiveness of these ABMTs, established by multi-lateral environmental agreements, needs to be assessed in terms of the spatial and temporal dimensions of those components of biodiversity which they identify as significant and/or which they are intended to protect, against predicted shifts in ecosystem dynamics. ABMTs under consideration are currently subject to review and scrutiny, through evaluations largely taking place independently of one another in line with the aims and obligations of the organisations responsible for their designation.

This report contributes to an evaluation of priorities for an expert assessment of OSPAR Marine Protected Areas (MPAs), CBD Ecologically or Biologically Significant Marine Areas (EBSAs), and FAO Vulnerable Marine Ecosystems (VMEs) as identified or currently proposed for the North Atlantic ABNJ and will inform an expert workshop in 2018. Main results of this study are:

- *The future of current ABMTs in the North Atlantic looks bleak in the context of climate change*. To evaluate priorities for ABMTs in ABNJ high resolution climate change predictions for the next 2 to 5 decades are needed.
  Temporal and spatial scales are crucial. Impacts will be felt within the next 20 years at a rate likely more rapid than many species can adapt and beyond resilience thresholds.
- Only hydrothermal vents and seeps which have a different ecosystem base from coral and sponge dominated communities show resilience to climate change.
- *Building a network of resilient ABMTs in the N Atlantic may require a profound review of the EBM concept* with a need for adaptive ABMTs and a significant reduction of other stressors.

Principal recommendations on priorities for an expert assessment on North Atlantic EBSAs, VMEs and MPAs in ABNJ are that:

- Spatial heterogeneity in the North Atlantic results in a need to 'future proof' ABMTs, emphasising resilience and refugia (+ ecosystem services function)
- Confidence in the effectiveness and reliability of climate models at a suitable spatial and temporal scale to inform management decisions in ABNJ is needed to make predictions about the robustness of areas with regard to climate change and ocean acidification using a case-by-case analysis. Current IPCC predictions do not allow for detailed assessment of ABMTs over a 30-50 year time scale.
- It is important to recognise a degree of commonality of purpose and consider these three categories of ABMTs collectively as a "network" in order to determine where new/alternative areas are best located; target monitoring and assessment; input to global MPA targets; contribute best available science to the negotiations for a new legally binding instrument to protect biodiversity beyond national jurisdiction; and inform marine spatial planning decisions.

1 Introduction

Human activities and global change have major impacts on the distribution and sustainability of living marine resources. Notably, "activities using non-living marine natural capital are exerting a greater range of pressures on the living natural capital (*i.e.* marine ecosystem capital) than those activities using the latter" generating "equity issues, as those dependent on healthy seas like fishing, aquaculture, tourism and biotechnology, may have their development opportunities hindered by those who do not depend directly on a healthy ecosystem"[1]. Healthy oceans and seas are central to human well-being and to the economic security of (coastal) nations.

The deep sea (> 200 m below sea level; c. 65% of the Earth's surface[2]), including specifically the deep North Atlantic, harbours ecosystems that support a biologically rich variety of life[3,4,5], and which are crucial to the cycling of primary production, carbon and nutrients from the ocean surface to the deep seafloor[6]. Many of these ecosystems also provide important fish habitat[7,8,9]. In addition to provisioning services like fisheries, these ecosystems provide regulatory and cultural services that underpin conservation measures to help secure the well-being and economic security of Atlantic nations and their citizens[10]. It is known that the impacts of human activities on deep-sea ecosystems can span extensive areas and extremely long time frames, and act synergistically, eventually leading to regime shifts and affecting deep-ocean life support services[11,12,13,14]. However, there are still significant/severe knowledge and governance gaps that challenge our capacity to adequately manage human activities and ensure the long-term health and resilience of these ecosystems[15,16].

Clearly, dealing with the multiple and increasing pressures placed on the ocean, specifically on the deep sea, and balancing Blue Growth against long-term sustainability, is an urgent task requiring adequate governance and management systems and thorough evaluation of cumulative impacts, grounded on sound science. That is the object of the EU H2020 ATLAS Project, notably through its Workpackage (WP) 7 on "policy integration to inform key agreements". ATLAS WP7 has four objectives:

1. Ensure that policy-makers and stakeholders have access to the findings of ATLAS research, thus allowing improved scientific knowledge to encourage innovation in maritime industries and promote exploitation of Atlantic marine resources in an ecologically, socially and environmentally sustainable way.

2. Provide the EU with science-based recommendations to inform the Atlantic Strategy[17] and its Action Plan[18], supporting both a multi-level governance approach and spatial planning policy for the Atlantic.
3. Generate synergies with other European policies (research and innovation, transport, environment, energy, technology, tourism, fisheries and aquaculture and international cooperation).
4. Inform and engage with international processes making a concerted effort to put the objectives of the Galway Statement[19] into practice.

One of the main tasks in this WP is the review of the current and likely future status of North Atlantic Area-Based Management Tools (ABMTs) in Areas Beyond National Jurisdiction (ABNJ) informed by predicted shifts in ecosystem dynamics to provide initial results to international processes scheduled during the ATLAS project. It also aims to provide clear messages of biodiversity resilience 'hotspots' within VMEs and EBSAs to be recognised by regulators.

This report (deliverable 7.2.) specifically aims to contribute to an evaluation of priorities for an expert assessment of Ecologically or Biologically Significant Marine Areas (EBSAs), Vulnerable Marine Ecosystems (VMEs) and Marine Protected Areas (MPAs), as identified or currently proposed for the North Atlantic Areas Beyond National Jurisdiction (ABNJ) and to inform an expert workshop in 2018. The effectiveness of these ABMTs, established by multi-lateral environmental agreements, needs to be assessed against the conservation objectives for which they have been established. Specifically, it requires an assessment in terms of the spatial and temporal dimensions of those components of biodiversity which they identify as significant and/or which they are intended to protect, against predicted shifts in ecosystem dynamics in ABNJ in the north Atlantic.

This chapter starts by presenting the ATLAS project, and by demonstrating its EU/regional and international relevance in terms of these specific area-based management tools in the context of the existing and developing international ocean governance framework. The chapter closes with an overview of the existing network of ABMTs in the ABNJ in the North Atlantic that will be the object of the next chapters: OSPAR MPAs (Chapter 2), CBD EBSAs (Chapter 3), FAO VMEs (Chapter 4).

1.1 The EU H2020 ATLAS project

The main focus of the ATLAS project – A Trans-AtLantic Assessment and deep-water ecosystem-based Spatial management plan for Europe – is on providing essential new knowledge of direct relevance to North Atlantic ecosystems through data gathering and synthesis, to inform and facilitate stakeholder agreement on marine policy and regulation and to spur Blue Growth. ATLAS tackles this by developing an ambitious trans-Atlantic programme to provide the missing scientific understanding needed to fill these gaps. ATLAS takes a comprehensive approach to living marine resources in the North Atlantic, investigating interconnections between ocean circulation, surface production, and the functioning, biological richness and socioeconomic importance of Atlantic ecosystems. This holistic view should underpin the science-led policies that governments and businesses need to ensure ecosystem preservation. ATLAS activities focus on the deep ocean (200-2000 m water depth) where the greatest gaps in our understanding lie and where certain populations and ecosystems are known to be under pressure. This focus will provide international policy makers with the best data, tools and understanding needed for sound adaptive management of the deep ocean as patterns of marine resource exploitation change. To implement key agreements to protect biodiversity, ocean management knowledge is needed at the ocean basin scale. New information generated by ATLAS will enhance the purpose-built trans-Atlantic observing arrays to predict ecosystem tipping points and use this unique basin-scale infrastructure to deepen our understanding of the importance of ocean currents in controlling species distribution and connectivity to drive forward an ambitious new decision support tool for integrated Maritime Spatial Planning (MSP).

The consortium includes 24 + 1 multi-stakeholder, multidisciplinary partners from leading organisations with 12 universities, 4 national research institutes, 5 small and medium sized enterprises, and 4 government agencies across 10 European countries (including all Atlantic EU Member States), Canada and the USA (cf. Figure 1.1. for the geographic distribution/coverage of ATLAS project partners and case studies).

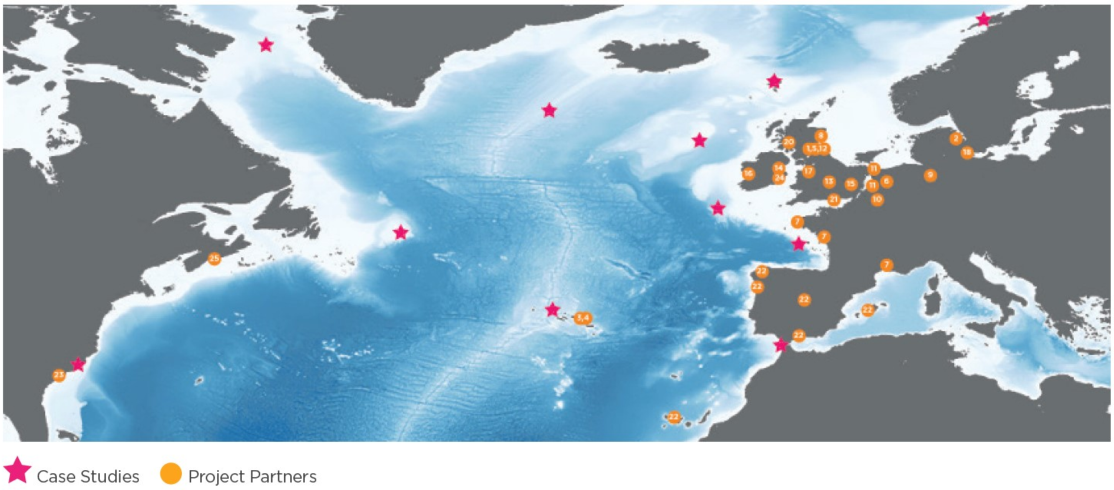

Figure 1.1. Geographic distribution/coverage of ATLAS project partners and case studies.

1.1.1 ATLAS' objectives – from science to action (science, policy, society, industry measures)

To achieve its goals of providing businesses and other stakeholders with science-led policies to ensure ecosystem management (Box 1.1.) and sustainable resource exploitation, ATLAS has four overarching objectives:

1. Improve understanding of deep Atlantic marine ecosystems and populations (200-2000 m) by collecting and integrating high-resolution measurements of ocean circulation with functioning, biological diversity, genetic connectivity and socioeconomic values.
2. Improve the capacity to monitor, model and predict shifts in deep-water ecosystems and populations in response to future change through better understanding of the connections between physical parameters and biological characteristics to support sustainable exploitation in the North Atlantic.
3. Transform new data, tools and understanding into robust ocean governance in line with an adaptive ecosystem-based maritime spatial planning (MSP) approach to achieve ecosystem preservation, sustainable exploitation and Blue Growth.
4. Scenario test and develop science-led, cost-effective adaptive management strategies for sustainable use of living and non-living resources that stimulate Blue Growth.

Box 1.1. What is Ecosystem-based management (EBM)?

Ecosystem-based management (EBM), also referred to as ecosystem management, and as the "ecosystem approach", is "a paradigm to explicitly account for the interconnectedness among systems, the cumulative impacts to ecosystems and to integrate ecological, social, economic and institutional perspectives, recognising their strong dependencies"[20]. As defined in the Convention for Biological Diversity (CBD), "the ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way" recognizing that "humans, with their cultural diversity, are an important component of many ecosystems"[21]. EBM is grounded on the notion that "ultimately we are managing people's influences on ecosystems, not ecosystems themselves"[22]. Three key aspects of EMB can be considered[23]: i) *Acknowledging connections*, including, first and foremost, the inextricable dynamic linkages between ecosystems and social systems, or "coupled social-ecological systems", meaning that "EBM is fundamentally a place-based approach"; ii) *Cumulative impacts* of multiple activities (and the individual actions therein) and how they affect the delivery of ***ecosystem services*** that flow from these coupled social-ecological systems; iii) *Multiple objectives*, *i.e.*, the range of benefits humans receive from ecosystems, "rather than single ecosystem services".

Ecosystem services may be defined as "the benefits human populations derive, directly or indirectly, from ecosystem functions"[24].

ATLAS will provide the first coherent, integrated basin-scale assessment of Atlantic deep-water ecosystems and their Blue Growth potential. The project's ambition is to significantly advance the state-of-the-art in basin-scale modelling and the field's predictive and ecosystem monitoring power, and heighten marine ecology policy effectiveness (Figure 1.2.). The full integration of the project's comprehensive data-gathering activities allows the consortium to work with businesses to roll out the first range of adaptive MSP across Atlantic jurisdictional regimes and to engage with policy at the highest levels.

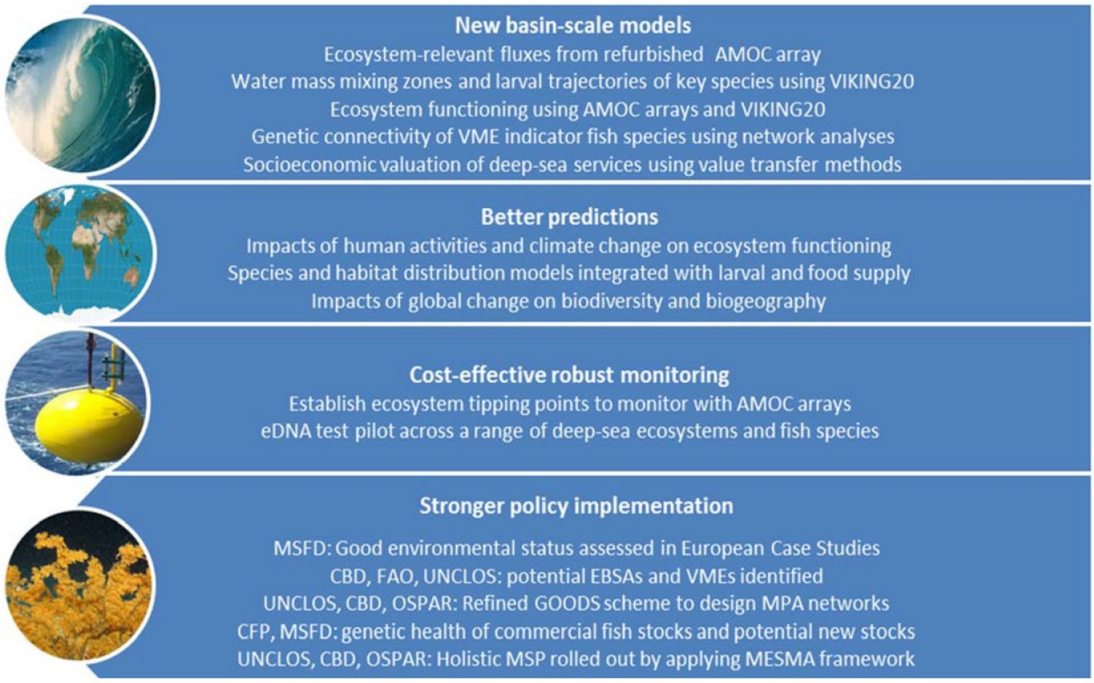

Figure 1.2. Innovation beyond the state-of-the-art in modelling, predicting, monitoring and policy implementation (Figure from the ATLAS project proposal).

1.1.2 ATLAS outputs /impacts

The main expected impacts of the ATLAS project are:

- Improve management (ecosystem approach) and governance of resources to preserve them and unlock their potential for the sustainable generation of new products and industrial applications;
- Improve cooperation among EU Member States with respect to Atlantic ecosystem based research as well as with international partner countries;
- Contribute to the implementation of the EU Integrated Maritime Policy, its environmental pillar the Marine Strategy Framework Directive (MSFD), the Common Fisheries Policy (CFP), the EU 'Maritime Strategy for the Atlantic Ocean Area', and the Galway Statement on Atlantic Ocean Cooperation; and
- Contribute to the implementation of international agreements to conserve Vulnerable Marine Ecosystems and Ecologically or Biologically Sensitive Areas.

Table 1.1. synthesises the major knowledge gaps and ATLAS outputs to achieve impact for users and stakeholders.

Table 1.1. ATLAS outputs addressing major knowledge gaps.

Knowledge gap	ATLAS outputs	Users	Impact
1. Identification of ecosystem services (ES) in N Atlantic areas, present and potential, tradeoffs and risks	Definition of services, risks and trade-offs on a broader Atlantic scale	Managers in different sectors, Policymakers, Environmental NGOs, Researchers	Improved understanding of services, risks and trade-offs for Blue Growth (BG)
2. Lack of understanding of socio-economic and public values connected to ES and non-marketed goods and services	Quantified values connecting services Atlantic basin-scale and willingness to pay for conservation and protection of potential future ES	Managers in different sectors, Policymakers, Environmental NGOs, Researchers	Informed political decision making and BG development based on values connected to ES, and value trade-offs for BG including nonmarket values connected to marine ecosystems
3. Undefined management units of key fisheries species	Delineation of population structure in time and space	RFMOs, Fisheries industries	Delineation of biological units is essential for sustainable fisheries management
4. Role of coral, sponge and chemosynthetic ecosystems in ES	**4.** Role of coral, sponge and chemosynthetic ecosystems in ES	Fisheries managers/industry, Ecosystem managers, Biodiversity conservation stakeholders	Knowledge to enable much more complete and effective MSP and multilayer management
5. Climate change resilience and feedback effects on deepwater ecosystems	Model scenarios under current AMOC conditions and under scenarios of 'reduced strength' AMOC in the future	EU and international policy makers, NGOs, Researchers, Socioeconomists, Industry.	Enhanced knowledge on deep-sea ecosystem resilience; improved determination of boundary conditions of environmentally sustainable exploitation activities now and in the future
6. Location and predictive models of Atlantic VME distribution	Predictive species and habitat mapping across several Atlantic areas	Research Institutions, Governments, RFMOs, Industry	Improved rationale for MPAs and closed areas. Better regulations on fishing and other deep-sea human activities and protection of VMEs. Update of threatened habitat/species lists
7. Lack of effective methodology for ocean scale Environmental Impact Assessments (EIAs)	Technologies for rapid assessment of biodiversity (BD), habitat mapping and extent. Standardised protocols for BD inventories in EIAs for deep-sea exploitation; Demonstration of methodology and protocols for EIAs	EU and International policymakers, Governments, Industry partners, RFMOs, Research organisations, FAO	Improved sustainability of existing and new fisheries aquaculture and marine resources. Scientific support for implementation of effective measures to protect VMEs based on the best available scientific information
8. Identify potential new resources still to be discovered/ explored and rationale for sustainable resource explor.and exploitation	Provide basic knowledge for exploration and exploitation of new living and non-living resources	Industry partners and BG industries	Improved prospects for sustainable exploration and exploitation of new living and non-living resources
9. 'Invisibility' of deep-water ecosystems and their goods and services to policy makers and society	Integrated assessment of BD, ecosystem functioning, species connectivity, societal value of Atlantic VMEs, public outreach	EU and international policy makers, Researchers, Socioeconomists, General public	Improved international and EU policy, planning and research, *e.g.* in the context of the Atlantic Strategy and Atlantic Ocean cooperation
10. Relationships of Atlantic ecosystems to food quality and supply	Understanding of thresholds and tipping points in food supply	EU and international policy makers, RFMOs, General public	Improved international and EU policy, planning and research, in the context of ocean food quality and security

It is important to note here two complementary projects taking place in parallel with the ATLAS project:

- SponGES (Deep-sea Sponge Grounds Ecosystems of the North Atlantic is an international research and innovation project with EU, USA, and Canadian partners. It is funded under EU's H2020 Blue Growth BG1 call and its overarching goal is the development of an integrated ecosystem-based approach to preserve and sustainably use deep-sea sponge ecosystems of the North Atlantic (**http://www.deepseasponges.org/**).
- MERCES (Marine Ecosystem Restoration in Changing European Seas) is an international research project encompassing partners from 16 EU and non-EU countries. It is also funded under H2020, focusing on the restoration of degraded marine habitats, including in the deep sea (**http://www.merces-project.eu/**).

Also relevant for ATLAS is the Atlantic Ocean Research Alliance (AORA), tasked with supporting the implementation of the Galway Statement (http://www.atlanticresource.org/aora/) (see section 1.2.3. below).

1.2 EU and regional (Atlantic) ocean governance framework and agreements

1.2.1 EU's Blue Growth strategy

The European Commission's (EC) Blue Growth strategy (COM(2012) 494 final) is "an initiative to harness the untapped potential of Europe's Oceans, seas and coasts for jobs and growth"[25]. It was published in 2012, aiming to drive forward the EU's Integrated Maritime Policy (IMP) and helping "to steer the EU out of its current economic crisis"[26]. It proposed to do this by promoting the EU's blue economy, representing at the time an estimated 5.4 million (10^6) jobs in economic activities related to the sea (excluding military activities) and almost €500 billion/year[27]. It is considered as the maritime arm/dimension of Europe's 2020 strategy for smart, sustainable and inclusive growth[28].

The EC's Blue Growth Strategy aims to "contribute to the EU's international competitiveness, resource efficiency, job creation and new sources of growth whilst safeguarding biodiversity and protecting the marine environment, thus preserving the services that healthy and resilient marine and coastal ecosystems provide"[29]. In fact, the text of the communication stresses that "the blue economy needs to be sustainable and to respect potential environmental concerns given the fragile nature of the marine environment"[30].

In addition to traditional sectors of the blue economy deemed crucial for value and jobs (shipbuilding and ship repair, cargo and ferry transport, fisheries, and offshore oil and gas) five new focus areas were identified: blue energy (marine renewable energies such as offshore wind, tidal, wave, and ocean thermal energy conversion); aquaculture; tourism (maritime, coastal, and cruise); marine mineral resources; and blue biotechnology (medicines, industrial enzymes).

Implementation of the Blue Growth Strategy is coupled and reinforced by other EU initiatives, including, *i.a.*, as the Marine Strategy Framework Directive (MSFD), which adopts an ecosystem-based management approach, and sea-basin strategies, such as the Maritime Strategy for the Atlantic Ocean Area (COM(2011) 782 final).

1.2.2 EU's Maritime Strategy of the Atlantic Ocean Area (Atlantic Strategy)

A Maritime Strategy of the Atlantic Ocean Area (COM(2011) 782 final) was launched in 2011 with five objectives concurring to the "overriding objective of creating sustainable jobs and growth" of EUROPE 2020: implementing the ecosystem approach; reducing Europe's carbon footprint; sustainable exploitation of the Atlantic seafloor's natural resources (marine raw materials); responding to threats and emergencies; and socially inclusive growth[31]. The corresponding action plan – Action Plan for a Maritime Strategy in the Atlantic area: Delivering smart, sustainable and inclusive growth (COM(2013) 279 final) – was published in 2013 to be implemented through to 2020. It was intended as an invitation to the private sector, academia, public bodies and other stakeholders to design projects aimed to respond to four priorities: 1) promote entrepreneurship and innovation; 2) protect, secure and develop the potential of the Atlantic marine and coastal environment; 3) improve accessibility and connectivity; and 4) create a socially inclusive and sustainable model of regional development[32].

1.2.3 Galway Statement (EU-Canada-USA)

The Galway Statement on Atlantic Ocean Cooperation is an EU-Canada-USA research alliance signed in Galway, Ireland, on 24 May 2013. It was intended to advance the shared vision of the signatory nations "of an Atlantic ocean that is healthy, resilient, safe, productive, understood and treasured so as to promote the well-being, prosperity, and security of present and future generations"[33]. It aimed to i) take stock and use "existing bilateral science and technology cooperation (…) and multilateral cooperation frameworks", including initiatives related to ocean observation and ocean literacy; ii) recommend priorities for future cooperation; and iii) coordinate relevant activities in these fields. Such cooperation should involve the public (including EU and national partners) and private sector, and the scientific community. Such an international partnership and cooperation should contribute to "increase our knowledge of the Atlantic Ocean and its dynamic systems"[34].

1.3 ATLAS' relevance for EU and regional (Atlantic) ocean governance framework and agreements

1.3.1 ATLAS' relevance for Blue Growth

The impacts of ATLAS will directly contribute to several of the minimum requirements identified in the EC's Blue Growth strategy and are expected to be pertinent to sectors with Blue Growth potential (Table 1.2.). In so doing, it is expected that ATLAS will have a direct positive impact on fostering an improved investment climate and, therefore, on the acceleration of sustainable economic activity.

1.3.2 ATLAS' relevance to the Atlantic Strategy

Through several of its project components, ATLAS is inspired by and contributes to the Atlantic Strategy. It does so in a variety of ways: by directly addressing challenges and opportunities, such as "implementing the ecosystem approach", "sustainable exploitation of the Atlantic seafloor's natural resources", and providing the grounds for "socially inclusive growth". The intention is to take advantage of and build bridges between identified EU tools: Horizon 2020, the Common Fisheries Policy, the Marine Strategy Framework Directive, flagship initiatives on marine knowledge and the MSP Directive, and foreign policy instruments, promoting dialogue with other Atlantic partners (see Galway statement, below). Lastly, by forwarding its implementation as recommended in the Atlantic Strategy based on enhanced cooperation, engaging, beyond Member States, with regions, academia, private industry, and other relevant stakeholders.

1.3.3 ATLAS relevance to the implementation of the Galway Statement

The ATLAS project offers a contribution to the EU and international implementation of the Galway Statement, signed by the EU, USA and Canada in May 2013 to launch a Transatlantic Ocean Research Alliance with the goal of working together to better understand and 'increase our knowledge of the Atlantic Ocean and its dynamic systems - including interlinks with the portion of the Arctic region that borders the Atlantic' and to promote the sustainable management of its resources. From its inception, ATLAS has been designed and developed with partners from Europe, Canada and the USA who are unified through a shared vision to foster trans-Atlantic research, innovation and management to underpin Blue Growth.

Table 1.2. Expected impacts of ATLAS in relation to sectors with Blue Growth potential

BG Potential	ATLAS Impact
Fisheries and aquaculture	Use and further develop molecular methods to assess connectivity within marine species of economic importance. In addition to adding essential data for management, the project will also improve on methodology that will lead to cheaper and faster molecular approaches to be implemented as management tools. Sustainably managed deep-sea ecosystems can provide economically valuable fisheries resources. The study of economically important fisheries species will have a direct impact on how these species are managed by EU regional, national and local managers and how the resource is used by fishing industries. Sustainable management of the fisheries resource will ensure that the economic benefits provided by fisheries will be maintained in the future.
Oil and gas	Offshore production of oil and gas contributes very substantially to the EU's Blue Economy. Indeed domestic EU production is largely offshore with a strong value chain that supports many other marine and land-based industries. More than 5% of the world's liquid hydrocarbon resources are believed to lie in deep-water reservoirs. However, developing them sustainably poses a number of technical and environmental challenges. ATLAS will contribute towards a data-sharing approach and gathering an inventory of environmental databases for baselines to plan future extraction projects, ensuring optimal protection of biodiversity near future operating facilities.
Marine mineral mining	Improved understanding of ecosystems can de-risk investments in developing EU resources for minerals such as rare-earth elements (95% produced in China) essential in manufacture of high-tech products used in transport, healthcare, aerospace and ICT. ATLAS MSP methodology and documentation will help planning and risk-reduction for sustainable extraction Hydrothermal vents can form exploitable mineral resources. Relative to the majority of the deep sea, the areas around hydrothermal vents are biologically more productive, often hosting complex communities making the requirement for understanding the complexity of their ecosystems highly relevant in terms of conflict with extraction opportunities. ATLAS will also build on existing synergistic collaborations with FP7 project MIDAS. ATLAS partner SC co-ordinates MIDAS. For example, MIDAS research to understand the environmental impact of particle-laden plumes will be given broader reach and context through ATLAS's uniquely detailed basin-scale hydrodynamic modelling. ATLAS work on mechanisms and controls for the dispersal and colonisation of seamount biota and taxonomy and genetic connectivity of seamount biota have all been identified as requirements for exploitation in this sector. This is particularly relevant to the mineral resources associated with the mid-Atlantic Ridge
Marine Biotechnology	Validated eDNA technology to census rich deep-sea biodiversity and Marine Genetic Resources for Blue Growth. ATLAS will work closely with Industry Associate Partner PharmaMar focussing on two complimentary aspects. Firstly PharmaMar will collaborate with taxonomic expertise on key deep-water species (*e.g.* sponges) and secondly, ATLAS will provide access to novel biological resources and samples for PharmaMar's anti-cancer screening programme. These opportunities will be further developed via the 2017 Blue Biotechnology Conference arranged by Associate Partner BluePharmTrain. These marine biotechnology specialists offer an unparalleled opportunity to heighten engagement with this emerging sector and provide unique access to ATLAS's network of deep-sea research cruises.
Marine Tourism	Although less popular in the EU, marine recreational fishing tourism is popular across the US generating significant economic impacts both locally nationally. Spending was US$ 4.6 billion on both trip-related expenses and fishing-related durable goods in 2012183. This contribution to the economy is critically dependent on natural resources including deep-sea fisheries and is already constrained in its periods of operation and scale by measures to protect fish stocks184. The impact of ATLAS on sustainable policies and MSP will be directly impact sustainability and future development of recreational fisheries. Several ATLAS Case Studies (*e.g.* Mingulay Reef Complex and LoVe Observatory) encompass areas with developing recreational sea angling interests and a sound understanding of deep-water fish associations and dependencies on deep-water habitats is needed for this sector to develop sustainably. These aspects will be grounded in ATLAS's novel socio-economic analysis of the goods, services and values of deep-water ecosystems (WP5), including those provided to tourism now and as optional values in the future.

1.4 International ocean governance initiatives

1.4.1 UN's Sustainable Development Goals – Goal 14

In 2015, the UN adopted the 2030 Agenda on Sustainable Development, along with 17 Sustainable Development Goals (SDGs)[35]. Goal 14, in particular, is aimed to "conserve and sustainably use the oceans, seas, and marine resources"[36]. Ten targets were defined under the

Ocean goal, related, i.a, to: reduce marine pollution; increase the protection and sustainable management of marine and coastal ecosystems to strengthen their resilience and achieve healthy and productive oceans; minimize/address impacts of ocean acidification, namely through enhanced scientific cooperation; regulate fisheries; conserve one tenth of coastal and marine areas, consistent with national and international law and based on the best available scientific information; Increase scientific knowledge, develop research capacity and transfer marine technology; and enhance the conservation and sustainable use of oceans and their resources by implementing international ocean law.

Like many of the other SDGs, SDG 14 does not strive to introduce new commitments. Rather existing targets, such as the Convention on Biological Diversity (CBD) Aichi Biodiversity Targets[37] are incorporated (see Figure 1.3.) and the SDG seeks to bring together resource use and conservation commitments.

1.4.2 UN BBNJ PrepCom Process

Due to the intensification of maritime activities and rising concerns about the deteriorating state of the oceans and marine biodiversity[38], a new international legally binding mechanism is presently being negotiated at the United Nations, under the umbrella of the United Nations Convention on the Law of the Sea (UNCLOS), *on the conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction* (BBNJ; Cf. Box 1.2. on ABNJ). This stemmed, *i.a.*, from recognition of "the inadequacy of UNCLOS and marine environmental instruments in combating the threats posed by human activities to biodiversity in the deep ocean"[39].

In 2004 the UN General Assembly decided to "establish an Ad Hoc Open-ended Informal Working Group to study issues relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction"[40]. In 2011, this 'BBNJ Working Group' recommended that a process be initiated, eventually through the development of a multilateral agreement under UNCLOS, to ensure a legal framework for the conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction[41]. The BBNJ Working group further recommended that this process would address "together and as a whole" (*i.e.*, in an integrated manner), a "package" of four topics: i) marine genetic resources (MGRs), including aspects related to benefit sharing; ii) measures such as area-based management tools (ABMTs) including Marine Protected Areas (MPAs); iii) Environmental Impact Assessments (EIAs), and iv) capacity-building and the transfer of marine technology[42] (Cf. Box 1.3.).

SDG 14 and the Aichi Biodiversity Targets

SDG 14: Conserve and sustainably use the oceans, seas and marine resources

SDG 14 Targets	Highly Relevant Aichi Biodiversity Targets
14.1: "By 2025, prevent and reduce **marine pollution**.."	Aichi Target 8
14.2: By 2020, sustainably manage and protect marine and coastal ecosystems including by **strengthening their resilience**, and take action for their **restoration**..."	Aichi Target 10; Aichi Target 15
14.3: "Minimize and address the **impacts of ocean acidification**..."	Aichi Target 10
14.4: "By 2020, **effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing** ..."	Aichi Target 6
14.5: "By 2020, **conserve at least 10 per cent of coastal and marine areas**..."	Aichi Target 11
14.6: "By 2020, **prohibit certain forms of fisheries subsidies** which contribute to overcapacity and overfishing..."	Aichi Target 6; Aichi Target 3
14.7: "By 2030, **increase the economic benefits** to Small Island developing States and least developed countries from the sustainable use of marine resources..."	Strategic Goal D; Targets 14, 15 and 16
14.a: "**Increase scientific knowledge**, develop research capacity and **transfer marine technology**..."	Aichi Target 19
14.b: "**Provide access for small-scale artisanal fishers** to marine resources and markets"	Aichi Target 18
14.c: "Enhance the conservation and sustainable use of oceans and their resources by **implementing international law**..."	Aichi Target 17

Figure 1.3. Relationship of the oceans goal (SDG 14) with the CBD's Aichi Biodiversity targets (cf. Annex 1). (reproduced with permission from CBD Secretariat).

BOX 1.2. What are Areas Beyond National Jurisdiction (ABNJ)?

ABNJ are areas beyond the limits of coastal state sovereignty and jurisdiction, *i.e.*, the High Seas and the Area. The High Seas comprise all parts of the sea not included in the Exclusive Economic Zone (EEZ), in territorial seas, or in archipelagic waters[43]. The Area refers to the seabed, ocean floor and subsoil, beyond the limits of national jurisdiction[44].

As such, ABNJ are subjected to two very distinctive jurisdictional frameworks under UNCLOS: the High Seas (Part VII) and the regime applicable to the Area (Part XI and Annex III)[45]. Also the total spatial extent of ABNJ will only be known once the outer limits of the continental shelves of coastal states beyond 200 nm are stabilized in accordance with the UN DOALOS Commission on the Limits of the Continental Shelf[46].

The development of this new international legally binding agreement was finally set in motion in 2015 through Resolution A/RES/69/292, which established a preparatory committee (PrepCom) to make substantive recommendations on the elements of a draft of an international legally binding instrument on BBNJ under UNCLOS[47], and restated the need to address the topics identified in the package agreed in 2011[48, 49]. This ongoing negotiation process is set against the "policy backdrop" of the UN's SDGs (2030 Agenda), specifically the obligation to sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, and to take action for their restoration to achieve healthy and productive oceans by 2020[50].

BOX 1.3. What are Area-based Management Tools (ABMTs)?

Although there is no universally accepted definition, ABMTs can be understood as providing "higher protection than the surrounding area due to more stringent regulation of one or more of all human activities, for one or more purposes", and are tailored to areas beyond national jurisdiction.[51,52]

ABMTs are generally used for the achievement of one or more objectives: protection and preservation of the marine environment; conservation of marine biodiversity; protection/safeguard of key ecosystem process; sustainable use of marine biodiversity (or components thereof); creation of scientific reference areas; safeguard of aesthetic/wilderness values; creation of buffer areas (under the precautionary approach); and avoidance/resolution of conflicting maritime activities.[53]

Although ABMTs are often simplistically equated to MPAs, they encompass a far broader set of tools: i) single-sectoral or sector specific; ii) multi-sectoral, encompassing several human activities; and iii) cross-sectoral (*i.e.*, non sector-specific or holistic) encompassing all human activities. Examples of single sectoral ABMTs include, for shipping, Emission Control Areas and Particularly Sensitive Sea Areas (PSSAs) within IMO and MARPOL[54]; for fishing, seasonal or year-round area closures, such as with the framework of NAFO[55]; for mining, the closures instituted by the International Seabed Authority in the Clarion-Clipperton Fracture zone in the Pacific Ocean[56]. MPAs are examples of multi-sectoral ABMTs, such as OSPAR's MPA network in the high seas.

1.4.3 EU's international ocean governance agenda

The EU is also committed to improving its ocean governance framework. In 2015, the EC conducted a public consultation on aspects related to international ocean governance, knowledge about the ocean, and role of the EU in shaping ocean governance[57]. Results confirmed that: i) "the current framework does not ensure the sustainable management of the oceans"[58], with a need for improved implementation and coordination and for filling legal gaps (such as those related to BBNJ); ii) existing knowledge gaps about the oceans "weaken the proper functioning of international ocean governance"[59] and there is a need for better knowledge (*e.g.*, on economic activities and the marine environment), and for improved coordination and data sharing; and iii) the EU has a major role to play in shaping international ocean governance, in terms of leadership, expertise, and cooperation with third partners.

Drawing from these results, in 2016, the EC and the High Representative for Foreign Affairs and Security policy adopted a joint Communication on international ocean governance[60]. This communication is "an integral part" of the EU's response to the United Nations' 2030 Sustainable Development Agenda, particularly its Ocean goal[61]. It set out 14 sets of actions in three priority areas: i) improving the international ocean governance framework; ii) reducing pressure on oceans and seas and creating the conditions for a sustainable blue economy; and iii) strengthening international ocean research and data (cf. Table 1.3.).

Table 1.3. EU's 2016 international ocean governance agenda: priority areas and corresponding actions.

IMPROVING THE INTERNATIONAL OCEAN GOVERNANCE FRAMEWORK
Action 1: Filling the gaps in the international ocean governance framework
Action 2: Promoting regional fisheries management and cooperation in key ocean areas to fill regional governance gaps
Action 3: Improving coordination and cooperation between international organisations and launching Ocean Partnerships for ocean management
Action 4: Capacity building
Action 5: Ensuring the safety and security of seas and oceans
REDUCING PRESSURE ON OCEANS AND SEAS AND CREATING THE CONDITIONS FOR A SUSTAINABLE BLUE ECONOMY
Action 6: Implementing the COP21 Agreement and mitigating the harmful impact of climate change on oceans, coastlines and ecosystems
Action 7: Fighting illegal fishing and strengthening the sustainable management of ocean food resources globally
Action 8: Banning harmful fisheries subsidies
Action 9: Fighting marine litter and the 'sea of plastic'
Action 10: Promoting maritime spatial planning (MSP) at global level
Action 11: Achieving the global target of conserving 10% of marine and coastal areas and promoting the effective management of MPAs
STRENGTHENING INTERNATIONAL OCEAN RESEARCH AND DATA
Action 12: A coherent EU strategy on ocean observation, data and marine accounting
Action 13: Strengthening investment in 'blue' science and innovation
Action 14: International ocean research, innovation and science partnerships

1.5 International relevance of ATLAS

The previous sections emphasize the international obligations of developing knowledge and know-how on the sustainable use of marine resources; the relevance of area-based management tools such as MPAs; and the need for capacity building based on the increase of scientific knowledge and its integration, further to the development of research capacity and on the transfer of marine technology, into marine policy and governance. All these aspects are at the core of the ATLAS project. In fact, the topic of scientific capacity, which is one of the key objectives of the ATLAS project, is for many a *conditio sine qua non* of the new legally binding instrument on BBNJ and as a cross-cutting feature in relation to other elements of the 2011 package"[62]. Not surprisingly, this notion is also supported in the EU's international ocean agenda, which considers sound scientific knowledge of the oceans as the crucial common denominator for the successful implementation of any actions related to sustainable resource use.

1.6 ATLAS deliverable 7.2.

As mentioned in the introduction to this chapter, one of the main tasks in this WP is the review of the current and likely future status of North Atlantic ABMTs in ABNJ and to contribute to an evaluation of priorities for an expert assessment of such areas (Figure 1.2.), specifically: OSPAR Marine Protected Areas (Chapter 2), CBD Ecologically or Biologically Significant Marine Areas (Chapter 3), FAO Vulnerable Marine Ecosystems (Chapter 4).

Chapter 5 of this report reviews the individual evaluation processes currently underway for OSPAR MPAs, CBD EBSAs and FAO VMEs and considers a number of more holistic initiatives relevant to determining priorities for expert assessment.

Chapter 6 analyses predicted mid to long term environmental shifts, and associated ecosystem dynamics, in the north Atlantic and their effects on significant components of biodiversity within these ABMTs.

Chapter 7 concludes with principal recommendations on priorities for an expert assessment on North Atlantic EBSAs, VMEs and MPAs in ABNJ.

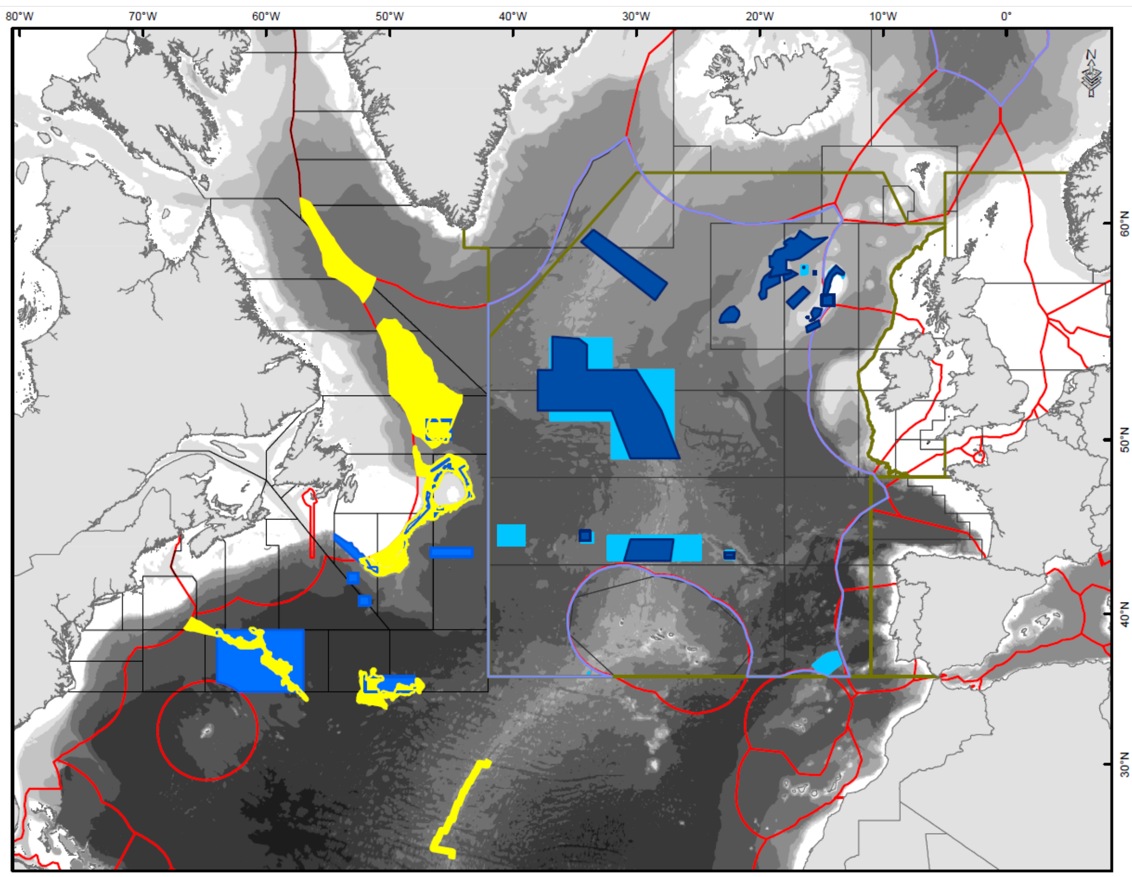

Figure 1.2. MPAs, EBSAs and VMEs in the N Atlantic in ABNJ. Red lines: contour of EEZs. Dark blue polygons: OSPAR MPAs; Yellow polygons: CBD EBSAs; bright blue polygons: FAO VMEs.

2 OSPAR's network of MPAs in ABNJ

This chapter presents OSPAR, the Regional Seas Convention for the North-East Atlantic (the Oslo and Paris Convention), and the process of developing the first network of high Seas MPAs covering three main chronological stages:

- From its inception to 2010, when 6 MPAs were established;
- 2010-2012, leading to the definition of a 7th MPA;
- 2012 – onwards, with the ongoing study of potential additional MPAs.

For the purposes of this study it highlights and compares the main characteristics of OSPAR's MPAs, knowledge gaps and potential Blue Growth opportunities.

2.1 OSPAR convention's mandate for the protection of the NE Atlantic

OSPAR[1] is the Regional Seas Convention for the protection of the marine environment of the NE Atlantic Ocean with a Maritime Area of 13.5 M km^2 (Figure 2.1).[63]

OSPAR's mandate includes the obligation to protect marine biodiversity[64]. OSPAR is only legally binding to its own Contracting Parties (15 European governments and the EU) and cannot regulate all human activities in the ABNJ under its jurisdiction, which comprises c. 40% of OSPAR's maritime area. OSPAR is the sole international organization within that area with a mandate for setting in place an integrated process for the protection of parts of its ABNJ from human activities and their cumulative impact on the basis of the ecosystem approach to management (including an assessment of the status of the marine environment, the identification of features to be protected, the establishment of objectives, and of monitoring measures)[65]. OSPAR has competence to regulate human uses and activities such as scientific research, cable-laying, dumping, construction of installations and artificial islands, and deep-sea tourism, but not other important activities such as fisheries, mining, or international shipping. Given the legal competence of other international organisations, OSPAR actively seeks to collaborate with such organisations to effectively carry out its mandate.[66]

[1] OSPAR started in 1972 with the Oslo Convention for the prevention of marine pollution by dumping from ships and aircraft, and was broadened two years later, in 1974, to include the Paris Convention for the Prevention of Marine Pollution from land-based sources. In 1992, both conventions were unified, updated and extended, creating the OSPAR ("OS" for Oslo and "PAR" from Paris) Convention.

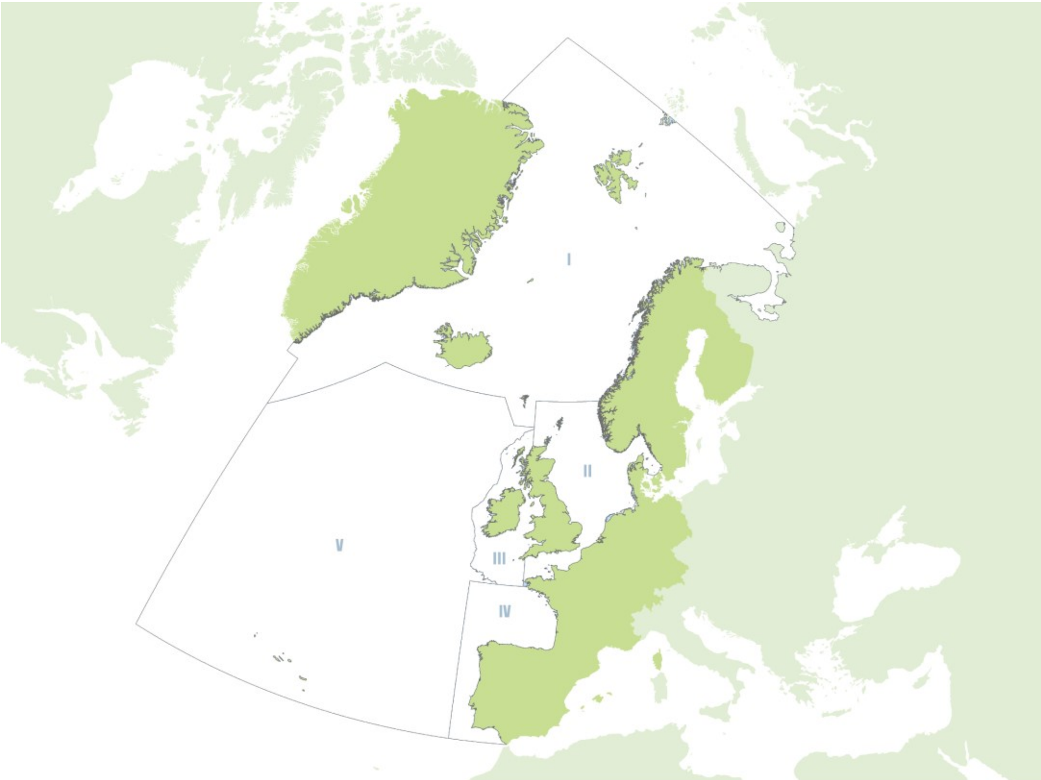

Figure 2.1. Geographic coverage of the OSPAR convention and its five composing regions: Arctic waters (region I); Greater North Sea (region II); Celtic Seas (Region III); Bay of Biscay and Iberian Coast (Region IV); and Wider Atlantic (region V) (image taken from the OSPAR website).

2.2 The process of developing OSPAR's network of high seas MPAs

In 1995, the Convention on Biological Diversity (CBD), through its Jakarta Mandate on conservation and sustainable use of marine and coastal biological diversity[67] obliged Parties to establish a global network of Marine Protected Areas (MPAs) (Box 2.1.). During the 2002 World Summit on Sustainable Development, 2012 was agreed as the deadline for the establishment of representative networks of MPAs. In 2003, OSPAR and HELCOM (the Helsinki Commission for the protection of the marine environment of the Baltic Sea) joined up to contribute to this target and agreed to create an "ecologically coherent network of MPAs by 2010"[68] including in ABNJ[69].

Box 2.1. What is a Marine Protected Area (MPA)?

MPAs may be defined in a variety of ways, depending, *i.a.*, on the objectives of their classification. For OSPAR, an MPA is "an area within the maritime area for which protective, conservation, restorative or precautionary measures, consistent with international law have been instituted for the purpose of protecting and conserving species, habitats, ecosystems or ecological processes of the marine environment".[70]

MPAs are seen as a measure to protect and conserve marine biodiversity, contribute to reduce the decline of biomass in the oceans (including the risk of fisheries collapse), and to counteract the negative impacts of human activities.[71]

MPAs are considered "key tools for securing ecosystem resilience and thus dealing with the uncertainties of our changing marine environment"[72]. MPAs can be considered as "small-scale models of ecosystem-based MSP"[73]. It has been argued that MPA networks could be promoted as "an essential component of achieving both GES and sustainable blue growth"[74].

The Worldwide Fund for Nature (WWF), an Observer Organisation within OSPAR, had been campaigning, since 2000, for the protection of sites within OSPAR's ABNJ, starting with a proposal for the protection of the Charlie-Gibbs Fracture Zone (CGFZ), in the Mid-Atlantic Ridge, thought to be particularly vulnerable to human activities. The CGFZ development process functionally worked as a "pilot" that supported better understanding on the use of criteria and conservation principles for the creation of MPAs established by OSPAR and other international organisations such as the Food and Agriculture Organisation (FAO) and CBD. It also contributed to the development of a Roadmap establishing useful considerations and steps (incl. the definition of timeframes and the involvement of other competent authorities, such as the IMO, ISA and NEAFC) for the adoption of MPAs in ABNJ in 2010, useful not just for the CGFZ for which it was developed but also for other proposals[75] (for a detailed account of the process cf. O'Leary *et al*., 2012).

In 2003, OSPAR adopted a set of ecological and practical criteria/considerations to guide the identification and selection of MPAs on its maritime area[76] (Table 2.1.). In 2007, a scoping report was commissioned from the University of York (UK) to investigate potential sites for high seas MPAs in the Wider Atlantic Region (OSPAR region V). By reviewing the scientific literature, mapping habitats, consulting with experts, and prioritising areas on grounds of vulnerability to direct impacts of human activities (mostly fishing), a set of MPAs were proposed[77].

Table 2.1. OSPAR's list of ecological and practical criteria/considerations to guide the identification and selection of MPAs on its maritime area

ECOLOGICAL CRITERIA/CONSIDERATIONS
1.Threatened or declining species and habitats/biotopes;
2. Important species and habitats/biotopes;
3. Ecological significance;
4. High natural biological diversity;
5. Representativity;
6. Sensitivity; and
7. Naturalness
PRACTICAL CRITERIA/CONSIDERATIONS
1. Size;
2. Potential for restoration;
3. Degree of acceptance;
4. Potential for success of management measures;
5. Potential damage to the area by human activities;
6. Scientific value

This process resulted in the designation, during the OSPAR Ministerial Meeting (23-24 September, 2010, Bergen, Norway) of the world's first network of MPAs in the High Seas[78]. This network included six MPAs: Charlie-Gibbs South MPA[79] (the northern part of the MPA had been subjected to a submission to the CLCS by Iceland in 2009 and was temporarily left out); the Milne Seamount Complex[80]; the High Seas superjacent to the Altair[81], Antialtair[82] and Josephine[83] seamounts; and the Mid-Atlantic Ridge North of the Azores[84,85].

In 2012, a seventh MPA, Charlie-Gibbs North High Seas MPA, was added[86] (Figure 2.2.).

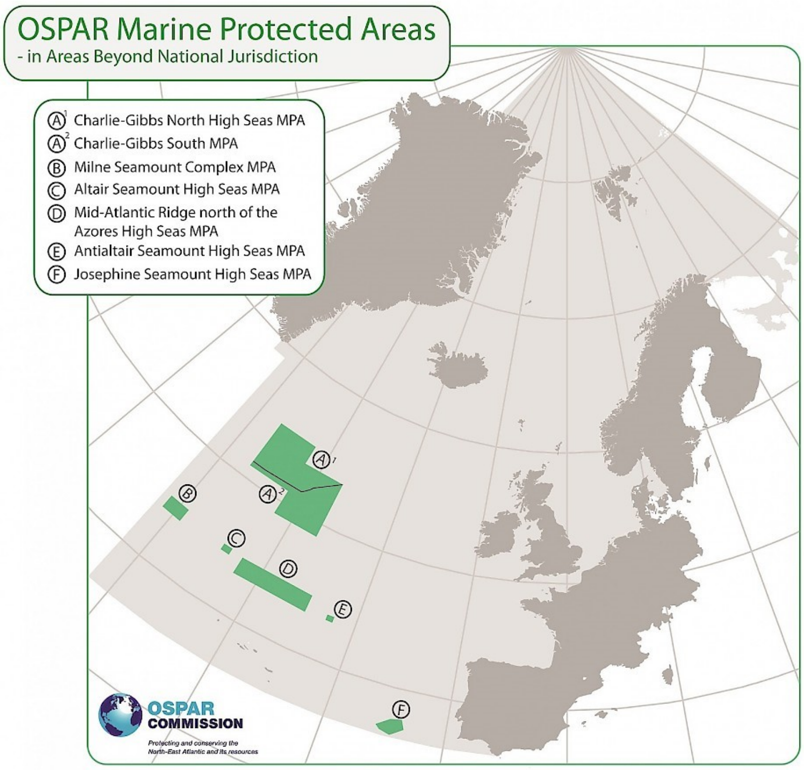

Figure 2.2. Current network of OSPAR MPAs in ABNJ. Figure online at https://www.ospar.org/.

Only the Milne Seamount Cluster and Charlie-Gibbs South lie wholly within both the High Seas and the Area. For the remaining MPAs, OSPAR has responsibility for the water column superjacent to the seabed subject to submissions to CLCS by coastal States: Altair Seamount, Anti-Altair Seamount, Josephine Seamount and a section of the Mid-Atlantic Ridge north of the Azores, have been designated by Portugal in conjunction with OSPAR (meaning that OSPAR measures for these MPAs are complemented by Portugal's management measures for the seabed of those same MPAs); as for Charlie Gibbs North MPA, only the water column is protected, as Iceland prefers to await a CLCS decision before committing to an MPA[87,88].

Table 2.2. compares these 7 MPAs in terms of their main characteristics, vulnerabilities, knowledge gaps and potential Blue Growth opportunities (individual tables for each OSPAR MPA are included in Annex I). Information contained in these tables was extracted from the OSPAR background documents on each of these MPAs, dated from 2010, 2011 and 2012. Any information produced since then is not included in this analysis. It is also important to note that the OSPAR MPAs were established on the basis of the precautionary principle and best available science: data and knowledge of deep-sea habitats is globally fragmentary.

Table 2.2. Synthesis of main characteristics of OSPAR High seas MPAs

MPA	Charlie-Gibbs North High Seas	Charlie-Gibbs South	Milne Seamount Complex	Altair Seamount High Seas	Mid-Atlantic Ridge N of the Azores	Antialtair Seamount	Josephine Seamount High seas
Features	178 651 km² Cool temperate waters; MAR N of the CGFZ seamounts	145,420 km² cool-temperate Atlantic waters MAR S of the CGFZ; seamounts	20,913 km² cool-temperate Atlantic waters W of the MAR	4408.71 km² warm-temperate Atlantic waters close to MAR	93,568 km² warm temperate (sub-tropical) waters of N Atlantic Province	2207.68 km² warm-temperate Atlantic waters	19,370 km² warm temperate waters of Atlantic deep-sea
Benthic	Cold water corals; sponges; deepwater fish, incl. sharks	Cold water corals; sponges; deepwater fish, incl. sharks	Cold water corals; sponges	Potentially cold water corals; sponges	Seamount; cold water corals, potentially *Lophelia pertusa* reefs	Cold water corals, coral gardens, sponge reef habitats	Cold water corals, sponges incl. endemisms
Pelagic	very high Pelagic productivity: fish, cephalopods, cetaceans	very high Pelagic productivity: fish, cephalopods, cetaceans	Fish; Cetaceans	Large diverse fish fauna expected to occur	Various spp. of fish, including sharks	Orange roughy and sharks; Cetaceans expected to occur	Orange roughy and sharks; may be imp. breeding area for sharks
Epipelagic	Seabirds Seaturtles (probable)	Seabirds Seaturtles (probable)	Foraging area for Seabirds Seaturtles	Pot. for seabirds; hotspot *C. caretta* juv.	core foraging area Cory's shearwater sea turtles	Potential	Poss. occur. seaturtles
Management measures	Awareness raising Information building; Marine science; New developments Third parties	Awareness raising Information building Marine science New developments Third parties	Awareness raising Information building Marine science New developments Third parties	Awareness raising Information building Marine science New developments Third parties	Awareness raising Information building Marine science New developments Third parties	Awareness raising Information building Marine science New developments Third parties	Awareness raising Information building Marine science New developments Third parties
Vulnerabilities (activities)	Fishing	Fishing	Fishing (low) Bioprospecting (pot. future) Mining (pot. future)	Fishing Bioprospecting (pot. future) Mining (pot. future)	Fishing Mining (potential) Scientific research (low)	Fishing Bioprospecting (pot. future) Mining (pot. future)	Fishing Bioprospecting (pot. sponges, etc)
BG opportunities	Bioprospecting potential	Bioprospecting potential	Bioprospecting and mining potential?	Bioprospecting and mining potential?	Mining potential?	Science (study effects of CC) Mining	Science (study effects of CC) Bioprospecting
Gaps/ uncertainties	Additional targeted research needed on BD and sensitivity of habitats and spp., part. sharks	Additional targeted research needed on BD and sensitivity of habitats and spp., part. Sharks	Additional research needed on naturalness/ pristineness; BD; ecological communities	Additional research needed on site specific info on bio/ecol. Need for better mapping and ecological info.	Additional research on productivity/ biomass in the MPA and beyond; BD; sensitivity of habitats/spp.	Additional research needed on site specific info on bio/ecol, incl. endemisms.	Additional research needed (incl. mapping) about seamounts and their BD

2.3 Expanding OSPAR's network of high seas MPAs

Examples of new potential sites to integrate in OSPAR's network of high seas MPAs include:

- Portugal is considering the creation of two additional high seas MPAs[89] (Figure 2.3.), which will require future consideration from OSPAR to match the protection of the superjacent water column:
  - The Madeira-Tore MPA (139,406.53 km^2): an expansion of the Josephine Seamount High Seas MPA spanning from the EEZ of mainland Portugal (Cape St. Vincent) to the EEZ of the archipelago of Madeira (warm-temperate Atlantic waters), over an area of extended shelf of varied bathymetry (2000-4000 m), to encompass many species and habitats associated with seamounts. Comprises several seamounts, incl. Josephine. Includes the Gorringe Bank. The northern part of the MPA is included in Regions IV and V while the southern part is outside the OSPAR Area;
  - The Great Meteor MPA (123,238 km^2): protecting a large area of ocean seabed and subsoil (in warm-temperate Atlantic waters) corresponding to a seamount complex (huge underwater archipelago) south of the Azores archipelago (outside OSPAR's maritime area). The MPA includes seamounts Great Meteor, Small Meteor, Plateau, Hyères, Irving, Plato, Atlantis, Tyro, and also Cruiser underwater plateau.
- Birdlife International, the world's largest nature conservation partnership, has proposed in 2016, the designation of "Evlanov Seamount and Basin" High Seas MPA in the OSPAR Maritime Area, which is now being considered by OSPAR[90] (Figure 2.4. and table 2.3), as a pelagic MPA based on seabird species richness and abundance using seabird tracking data.

OSPAR has also recently (2014-2015) considered proposals for an Arctic High Seas MPA, which have yet to be matured.

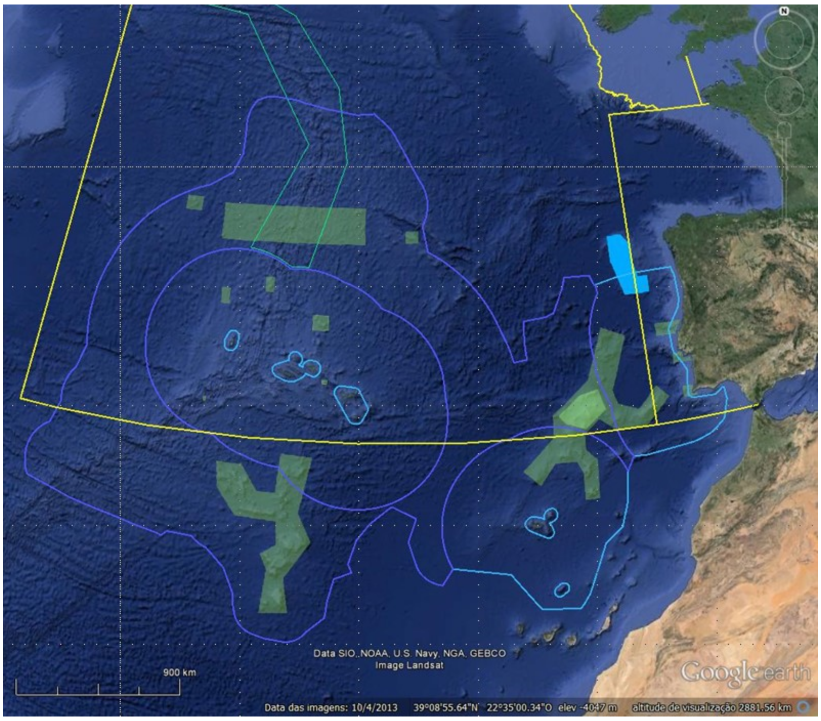

Figure 2.3. Portugal's existing and proposed high seas MPAs.

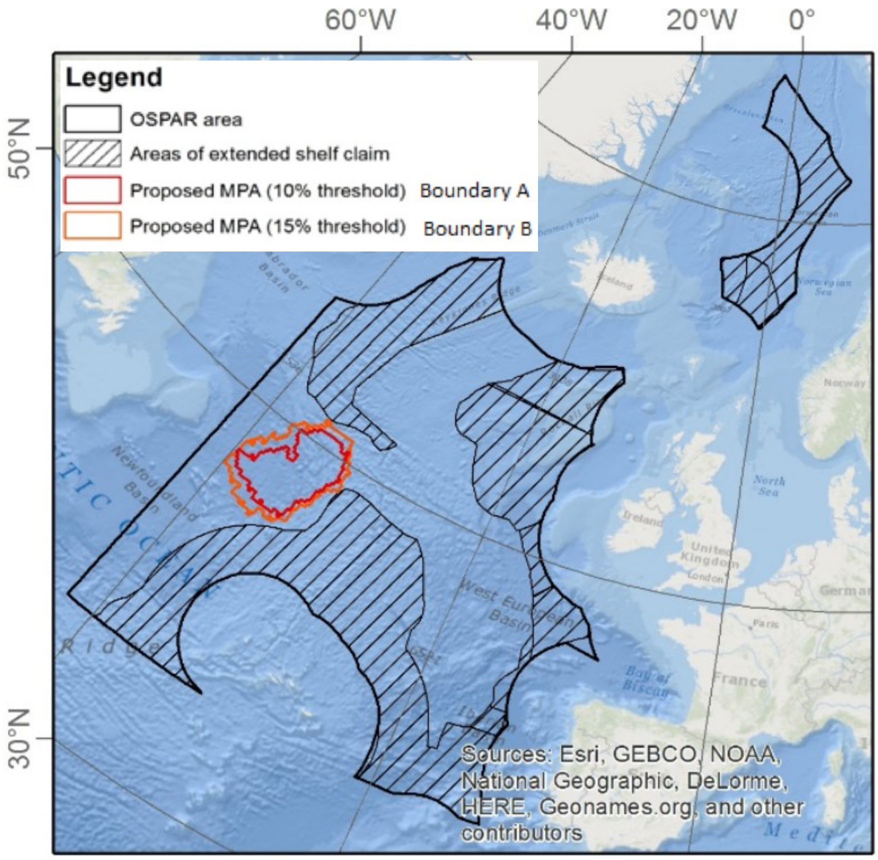

Figure 2.4. Proposed limits of Evlanov Seamount and Basin" High Seas MPA (Birdlife International, 2016).

Table 2.3. Evlanov Seamount and Basin MPA proposal[91]

Designation	Evlanov Seamount and Basin High seas MPA (ESB HS MPA)
Features	**Size:** 177,054 km^2 (Boundary A); 265,161 km2 (Boundary B) **Biogeographic region:** cool-temperate Atlantic waters (46-52ºN; 30-40ºW); N limit: CGFZ; E limit: Flemish Cap and Grand Banks; W limit: MAR. Complex topography and bathymetry (> 4,000 m deep) Located at the dynamic interface between different biogeographic provinces (incl. warm N Central Atlantic Province, Gulf Stream Province, N Atlantic Current Province and the cold Subarctic Atlantic Province) whose meeting and the associated hydrodynamic features forms the sub-polar front. This ecotone is characterised by particularly high productivity and biodiversity in comparison to adjacent waters and neighbouring biomes
Benthic/ Demersal	-
Pelagic	**zooplankton communities:** high abundance of copepods, gelatinous zooplankton and euphausiids. Copepods, such as *Calanus finmarchicus* and *C. hyperboreus,* found in high concentrations in some areas, are key prey for gelatinous zooplankton, mesopelagic fish, and some seabird species (eg. Little Auk, Alle alle) and are often associated with high seabird numbers in the N Atlantic as indicators of food abundance. **Mesopelagic fish:** abundant spp. include the Goiter Blacksmelt (*Bathylagus euryops*). Lanternfish (Myctophids) are also abundant (key prey for squid, cetaceans and seabirds) Important also for Bluefin tuna (*Thunnus thynnus*) and oceanic sharks, *e.g.* Mako Shark (*Isurus* spp.), Blue Shark (*Prionace glauca*), potentially Basking Shark (*Cetorhinus maximus*) **Cephalopods:** thought to be abundant within the region including oceanic spp. such as *Teuthowenia megalops, Gonatus streenstrupi, Grimpotheuthis discovery.* **Cetaceans:** Sei whale (*Balaenoptera borealis*) actively forages within the area. The general area around the [proposed] MPA is used by White-sided Dolphins (*Lagenorhynchus acutus*), Pilot Whales (*Globicephala* spp), Striped Dolphins (*Stenella coeruleoalba*), Common Dolphins (*Delphinus* spp.), Blue Whales (*Balaenoptera musculus*), Sperm Whales (*Physeter macrocephalus*); to the north of the CGFZ, Fin Whales (*Balaenoptera physalus*) Minke Whales (*Balaenoptera acutorostrata*) and Humpback Whales (*Megaptera noveangliae*)
Epipelagic (0-200 m)	**Seabirds**: high abundance and diversity (area consistently used by at least 18 spp. across all seasons); Top spp: Great Shearwater (*Puffinus gravis*), Leach's Storm-Petrel (*Hydrobates leucorhous*), and Cory's Shearwater (*Calonectris diomedea*), but also Black-legged kittiwake (*Rissa tridactyla*), Audubon's shearwater (*Puffinis lherminieri*), and Thick-billed murre (*Uria lomvia*) **Seaturtles:** Leatherback turtle (*Dermochelys coriacea*)
Management measures	Proposed: - Multi-taxa bycatch monitoring programme, involving on board data collection. - Implementation of bycatch mitigation measures if bycatch is shown to be a problem - Monitor/ build in seabird species prey needs to fish stock assessments and setting of catch limits - Assess scale of light pollution/collisions caused by shipping, fisheries and extractives and take measures to minimise as appropriate - Develop oil spill management plan - Develop a system for reporting of oil leakages in this area - Modelling of oil spill dispersion and necessary wildlife response (dependent on seasons/oceanography) - The restriction of dumping oil and other chemical substances
Vulnerabilities (activities)	**Fishing:** although it is known to occur inside the area, the exact extent of fishing effort in the area is unclear. **Shipping:** the area is quite intensively crossed by vessel traffic; Shipping activities could cause disturbance to seabirds and displacement from foraging grounds, and lights on deck at night could cause seabirds to collide with vessels. Vessel collision is also a potential threat to cetacean species **Bioprospecting**: no information **Mining**: no information.
BG opportunities	Science (not a direct BG field): study of the trophic dynamics within this region would be of high scientific value, and could also help monitor impacts of climate change on a range of different pelagic species. Tourism: ? Bioprospection: not likely Mining: Deeper cobalt crusts? Transport: -
Gaps/ Uncertainties	The complexities of the food web in the specific region of the [proposed] MPA are poorly known. Survey/monitoring work to determine if/which cetacean spp. are specifically using the area. More information concerning fishing and its effects in the area.

3 CBD's Ecologically or Biologically Significant Areas (EBSAs)

This chapter highlights the main aspects of EBSAs, Ecologically or Biologically Significant Marine Areas of the world's oceans, as identified by the Convention on Biological Diversity. This study highlights and compares the main characteristics of EBSAs that have so far been described in ABNJ in the North Atlantic.

3.1 The CBD's role in protecting the marine environment

The Convention on Biological Diversity (CBD), opened for signature at the 1992 Earth Summit in Rio de Janeiro, and entered into force in 1993, has three main goals: the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits from the use of genetic resources[92]. Specifically in relation to the marine environment (cf. Table 3.1.), in 2004 the 7th Conference of Parties (COP7) to the CBD committed to the 2002 Johanesburg target for representative networks of MPAs by 2012. CBD COP 7 established an Ad-Hoc open-Ended Working Group on Protected Areas with a mandate, *i.a.*, to "explore options for cooperation for the establishment of marine protected areas in marine areas beyond the limits of national jurisdiction, consistent with international law, including UNCLOS, and based on scientific information"[93].

Table 3.1. Main international objectives and targets for protection of the marine environment.

1992	**Rio Earth Summit's Agenda 21** called upon states to "identify marine ecosystems exhibiting high levels of biodiversity and productivity and other critical habitat areas and provide necessary limitations on use in these areas through, inter alia, designation of protected areas"[94]
2002	**Johanesburg Earth Summit Plan of Implementation** restated need to "maintain the productivity and biodiversity of important and vulnerable marine and coastal areas"[95]; defined specific targets for the establishment of MPAs "consistent with international law and based on scientific information, including representative networks by **2012**"[96]
2004	**CBD COP 7** set a target for "Effective conservation of at least 10% of each of the world's ecological regions by 2010".
2010	**Aichi Targets. Target 11:** By 2020, at least 10 % of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into seascapes.

In 2006, CBD COP 8 called for the convening of an expert workshop to "refine and develop a consolidated set of scientific criteria for identifying ecologically or biologically significant marine areas in need of protection, in open ocean waters and deep sea habitats, building upon existing sets of criteria used nationally, regionally and globally"[97]. That workshop, held in the Azores, Portugal, in 2007, took as its point of departure a set of scientific criteria first developed by Canada under its 1996 Oceans Act, that were already being employed nationally, to "facilitate provision of a greater-than-usual degree of risk aversion in management of activities in such areas", called Ecologically or Biologically Significant Areas (EBSAs)[98] (Cf. Box 3.1.).

Box 3.1. What are Ecologically or Biologically Significant Areas (EBSAs)?

EBSAs are ocean areas (from coastal to deep-sea habitats in ABNJ) believed to play a critical role in key ecological functions and processes, and which meet one or more of the seven scientific criteria adopted by CBD COP 9 in 2008 (cf. Table 3.2.). They refer to unique or rare areas anywhere in the ocean, and/or with high biological productivity, high biodiversity, important to unique/rare species or endangered species or habitats, with some degree of vulnerability and naturalness. They can describe anything from individual features to large ocean areas, and can be fixed or dynamic, moving with seasonal shifts.

EBSAs are focused solely on biological or ecological characteristics grounded on the best available scientific information and expert knowledge. EBSAs are described during dedicated regional workshops (cf. main text). They are not MPAs (or any other type of ABMTs), and do not provide management measures or restrictions to human activities. However, recognition of EBSAs can help decision-makers to prioritize and identify adequate management measures. [99]

In the 2007 expert workshop in the Azores a set of seven site-specific criteria were thus established (Table 3.2.) as well as a separate set of five MPA network criteria namely: EBSAs, representativity, connectivity, replicated ecological features, and adequate and viable sites[100]. Both sets of criteria were adopted at CBD COP 9, in 2008, in Bonn, Germany. According to Dunn *et al*. (2014), this separation of criteria for the identification of individual sites and for the establishment of networks of MPAs "was a unique CBD development, and remains the only internationally agreed-upon criteria system to formally recognise this distinction", and such a separation "has allowed EBSA descriptions to be useful for more than solely the design of networks of MPAs"[101].

3.2 Process for describing EBSAs

At CBD COP 10 in Nagoya, Aichi prefecture, Japan, a process for describing EBSAs through a series of regional workshops was agreed on[102]. The EBSA process uses a "structured UN regional approach" and "it is ecologically and politically coherent as it recognises the fundamentally connected nature of the marine environment at a regional scale, and the consequent responsibility which nations have toward their neighbours when their actions affect shared resources"[103].

Table 3.2. Scientific criteria for identifying ecologically or biologically significant areas in need of protection in open ocean waters and deep-sea habitats, their definition and the rationale for their relevance.[104]

Criteria	Definition	Rationale
Uniqueness or rarity	Area contains either (i) unique, rare or endemic species, populations or communities, and/or (ii) unique, rare or distinct, habitats or ecosystems; and/or (iii) unique or unusual geomorphological or oceanographic features	• Irreplaceable • Loss would mean the probable permanent disappearance of diversity or a feature, or reduction of the diversity at any level
Special importance for life-history stages of species	Areas that are required for a population to survive and thrive	Various biotic and abiotic conditions coupled with species-specific physiological constraints and preferences tend to make some parts of marine regions more suitable to particular life-stages and functions than other parts.
Importance for threatened, endangered or declining species and/or habitats	Area containing habitat for the survival and recovery of endangered, threatened, declining species or area with significant assemblages of such species	To ensure the restoration and recovery of such species and habitats
Vulnerability, fragility, sensitivity, or slow recovery	Areas that contain a relatively high proportion of sensitive habitats, biotopes or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery*	Degree of risk that will be incurred if human activities or natural events in the area or component cannot be managed effectively, or are pursued at an unsustainable rate.
Biological Productivity	Area containing species, populations or communities with comparatively higher natural biological productivity	Important role in fuelling ecosystems and increasing the growth rates of organisms and their capacity for reproduction
Biological Diversity	Area contains comparatively higher diversity of ecosystems, habitats, communities, or species, or has higher genetic diversity	Important for evolution and maintaining the resilience of marine species and ecosystems
Naturalness	Area with a comparatively higher degree of naturalness as a result of the lack of or low level of human-induced disturbance or degradation	• To protect areas with near natural structure, processes and functions • To maintain these areas as reference sites • To safeguard and enhance ecosystem resilience

*It is important to note that human activities are not considered in this or any other of the EBSA criteria, recognising, however, that their impacts are likely to influence biological or ecological characteristics deemed to be vulnerable[105].

Starting in November 2011, the CBD Secretariat convened regional workshops with regional partner organisations to enable the description of areas meeting EBSA criteria (cf. Figure 3.1. and Table 3.3.). Previously, a similar workshop was carried out for the NE Atlantic by OSPAR and the NE Atlantic Fisheries Commission (NEAFC), which was attended by the CBD Secretariat. The participation of the CBD Secretariat and technical teams in all the regional workshops has contributed to ensure consistency across them[106]. Additionally, a growing attention given throughout the process to offering training and capacity building prior to each regional EBSA selection workshop is believed to have increased the success of these workshops over time[107]. For a thorough description of the inception of the EBSAs process and its development see Dunn *et al.* (2014). For an analysis of the efforts of the CBD in describing EBSAs see Bax *et al.* (2016)[108]. For the complete information on process results see the CBD EBSA website (https://www.cbd.int/ebsa/).

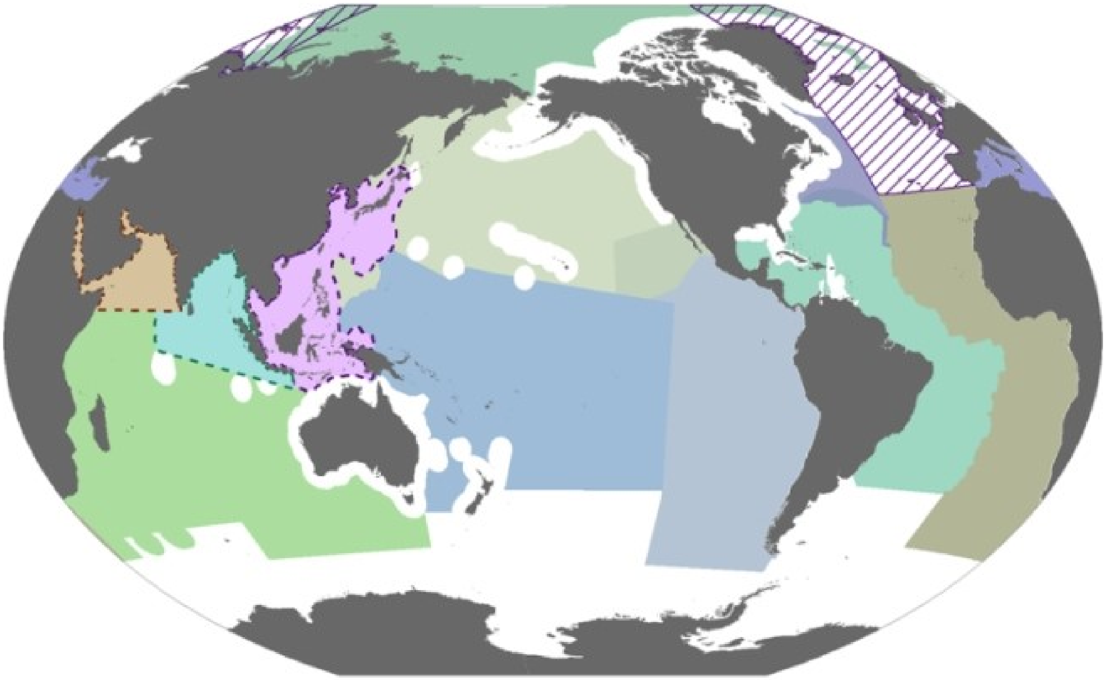

Figure 3.1. Geographical scope of regional workshop areas organized by the CBD Secretariat to facilitate the description of areas meeting EBSA criteria. Dashed outline indicate workshops convened in 2015. The hatched lines indicates a parallel ongoing process in the NE Atlantic (image sourced from the CBD EBSA website at https://www.cbd.int/ebsa/about) but see updates to figure in Table 3.3.

Table 3.3. CBD Regional EBSA workshops and other relevant meetings.[109, 110]

Region	Date	Host country
OSPAR/NEAFC NE Atlantic[2]	*Sep 11*	*France*
Western South Pacific	Nov 11	Fiji
Wider Caribbean and Western Mid-Atlantic	Feb 12	Brazil
Southern Indian Ocean	Jul 12	Mauritius
Eastern Tropical and Temperate Pacific	Aug 12	Ecuador
North Pacific	Feb 13	Russia
SE Atlantic	Apr 13	Namibia
Arctic	Mar 14	Finland
NW Atlantic	Mar 14	Canada
Mediterranean	Apr 14	Spain
NE Indian Ocean	Mar 15	Sri Lanka
NW Indian Ocean and Adjacent Gulf Areas	Apr 15	United Arab Emirates
Seas of East Asia	Dec 15	China
Black Sea and Caspian Sea	Apr 17	Azerbaijan

3.3 EBSAs in the North Atlantic

The majority of the North Atlantic region target of the ATLAS project falls under two of the CBD's regional areas for the definition of EBSAs: the NE Atlantic, and the NW Atlantic.

As mentioned in the previous section, the NE Atlantic was actually the first region worldwide where a workshop was carried out for the description of EBSAs, convened by OSPAR

[2] As previously explained this was not an 'official' CBD workshop.

and NEAFC and attended by the CBD Secretariat. During the workshop, the 25 participating scientists progressed from an initial intention of designating small, discrete EBSAs to reaching a consensus on eight large EBSAs (averaging 362,097 km^2 each) and two smaller Important Bird Areas (IBAs)[111] (Table 3.4. and Figure 3.2.).

Table 3.4. List of proposed EBSAs and IBAs resulting of the NE Atlantic regional workshop[112].

Area no.	Designation
Area 1.	Reykjanes Ridge south of Iceland EEZ
Area 2.	Charlie-Gibbs Fracture Zone and Subpolar Frontal Zone of the Mid-Atlantic Ridge
Area 3.	Mid-Atlantic Ridge north of the Azores (MARNA)
Area 4.	The Hatton and Rockall banks and Hatton–Rockall Basin
Area 5.	Around Pedro Nunes and Hugo de Lacerda Seamounts – IBA MAO3
Area 6.	Northeast Azores–Biscay Rise – IBA MAO3
Area 7.	Evlanov Seamount Region
Area 8.	Northwest of Azores EEZ
Area 9.	The Arctic Front – Greenland/Norwegian Seas
Area 10.	The Arctic Ice habitat – multiyear ice, seasonal ice, and marginal ice zone

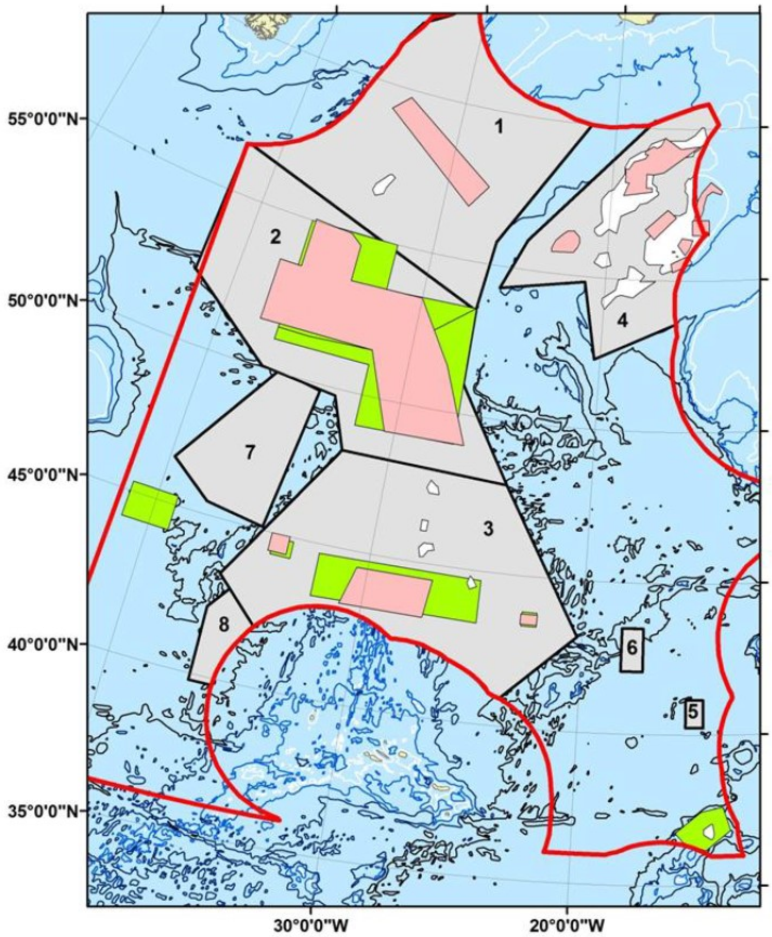

Figure 3.2. Map showing proposed EBSAs (Grey polygons); 1 = Reykjanes Ridge, 2 = Charlie-Gibbs Fracture Zone and Subpolar Frontal Zone, 3 = MARNA, 4 = Hatton–Rockall Plateau, 5 = Pedro Nunes and Hugo de Lacerda Seamounts, 6 = Northeast Azores–Biscay Rise, 7 = Evlanov Seamount, 8 = West of Azores). Existing NEAFC fishing areas are shown in white, NEAFC bottom fishery closures in pink, and OSPAR High Seas MPAs in green.

The International Council for the Exploration of the Sea (ICES) subsequently reviewed some of the scientific assumptions of the workshop at the request of the Contracting Parties to OSPAR and NEAFC. ICES proposed revisions and consolidated the areas described into fewer polygons. However, as yet OSPAR and NEAFC Parties have been unable to unanimously agree to submit the revised EBSA descriptions for scrutiny by the CBD process[113].

The NW Atlantic was addressed in a regional EBSA workshop held in Canada in March 2014. Seven EBSAs were described as a result of this workshop[114] (Table 3.5. and Figure 3.3.). Their main characteristics in terms of each EBSA criterion are described separately in Annex III (Tables AIII.1 to AIII.7) and compared in table 3.6.

Table 3.5. List of proposed EBSAs and IBAs resulting of the NE Atlantic regional workshop[115].

Area no.	Designation
Area 1.	Labrador Sea deep convection area
Area 2.	Seabird Foraging Zone in the Southern Labrador Sea
Area 3.	Orphan Knoll
Area 4.	Slopes of the Flemish Cap and Grand Banks
Area 5.	SE Shoal and Adjacent Areas on the Tail of the Grand Banks
Area 6.	New England and Corner Rise Seamount chains
Area 7.	Hydrothermal vent fields

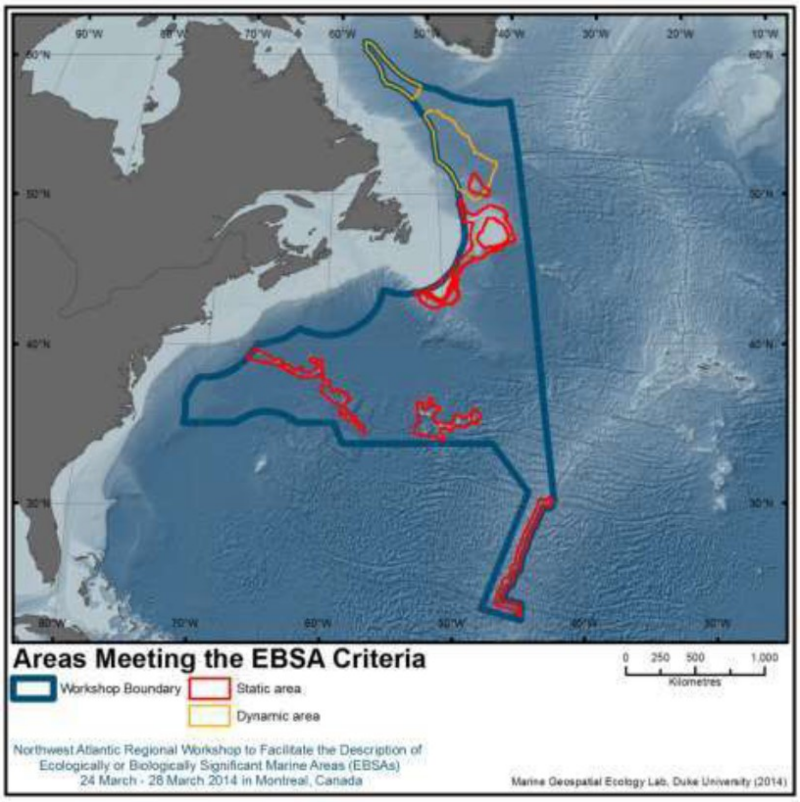

Figure 3.3. EBSAs in the NW Atlantic[116].

Table 3.6. Synthesis table of NW Atlantic EBSAs. Relevance: High | Medium | Low | No information

EBSA Criteria	Labrador Sea Deep Convection Area	Seabird Foraging Zone in the S Labrador Sea	Orphan Knoll	Slopes of the Flemish Cap and Grand Banks	SE Shoal and Adj. Areas on the Tail of Grand Banks	New England and Corner Rise Seamount chains	Hydrothermal vent fields
Uniqueness	crucial nexus in global ocean circulation; huge effect on downstream ecosystems	Aggregation of seabirds from large no. of widely dispersed colonies	Distinctive fauna due to unique mix of oceanographic/ geomorphological conditions	Unique in ABNJ in NW Atlantic with sponge grounds and sea pen concentrations	Unique relict bivalve populations (mussel and clam) and capelin (only known offshore spawning site)	Isolated seamounts with endemic populations and unique faunal assemblages.	High level of endemism; unique vent field driven by heat of exothermic reactions
Special importance for life-history stages of species	vast reservoir for *C. finmarchicus*	Foraging/wintering habitat for black-legged kittiwakes, thick-billed murre, Leach's storm-petrels		High coral/ sponge density offer shelter, feeding and breeding areas for other invertebrates and fish	cetaceans: foraging habitat for many spp. seabirds: critical feeding grounds fish: spawning and nursery areas	Deep-water corals, sponges and other benthic species. Gene flow corridor Nursery/feeding area for migratory spp.	Chemosynthetic primary producers dependent on vent water column
Importance for threatened, endangered or declining species and/or habitats		Imp. for black-legged kittiwakes, and Leach's storm-petrels		Northern bottlenose whale; northern & spotted wolfish. Deep-sea sponges, sea pens; coral gardens	Habitat for threatened and endangered whales and fish		
Vulnerability, fragility, sensitivity, or slow recovery	Water acidification (> than global average) increasing vulnerability of organisms with $CaCO_3$ structures	Long-lived, slow reproducing species of seabirds with slow recovery from disturbance	Long-lived, fragile cold-water corals and sponges with slow recovery from disturbance	Deep-sea corals and large sponges with slow recovery from disturbance	Long-lived species with slow recovery and relict populations sensitive to disturbance	Long-lived species of corals and sponges with slow recovery	Small structures and highly localized communities; vulnerable to introduction of taxa
Biological productivity	commensurate with subpolar regions	Higher 1^{ary} productivity varying over time and space	Little evidence of enhanced lower trophic levels in the water column	Particularly productive slopes. Many fish spp. attract top predators	Large spring phytoplankton bloom; shallow sandy habitat with high productivity		Dense populations of organisms
Biological diversity	commensurate with subpolar regions	Important habitat for seabirds	High benthic diversity compared to surroundings	Complex microhabitats high biodiversity	High specific diversity from phytoplankton to cetaceans	Very high benthic diversity; numerous endemic and novel corals	High diversity for areas without active venting
Naturalness	Effects of ocean warming and acidification	Ongoing and expanding human activities	No evidence of disturbance	Likely to have been little affected by human activities	Extensive fishing in the area	Some fishing; slopes and deeper summits not impacted	Low disturbance from surveys
Additional (IBA)	-	Qualifies as IBA	-	-	Qualifies as IBA for breeding and wintering species.	-	

Two CBD regions border the N Atlantic: The Arctic, and the Wider Caribbean and Western Mid-Atlantic. For the Arctic Ocean none of the EBSAs identified have a direct relevance for the ATLAS project (Figure 3.4.). However, the Arctic EBSA Workshop did review data for areas of ABNJ within the Arctic circle in the OSPAR Maritime Area.

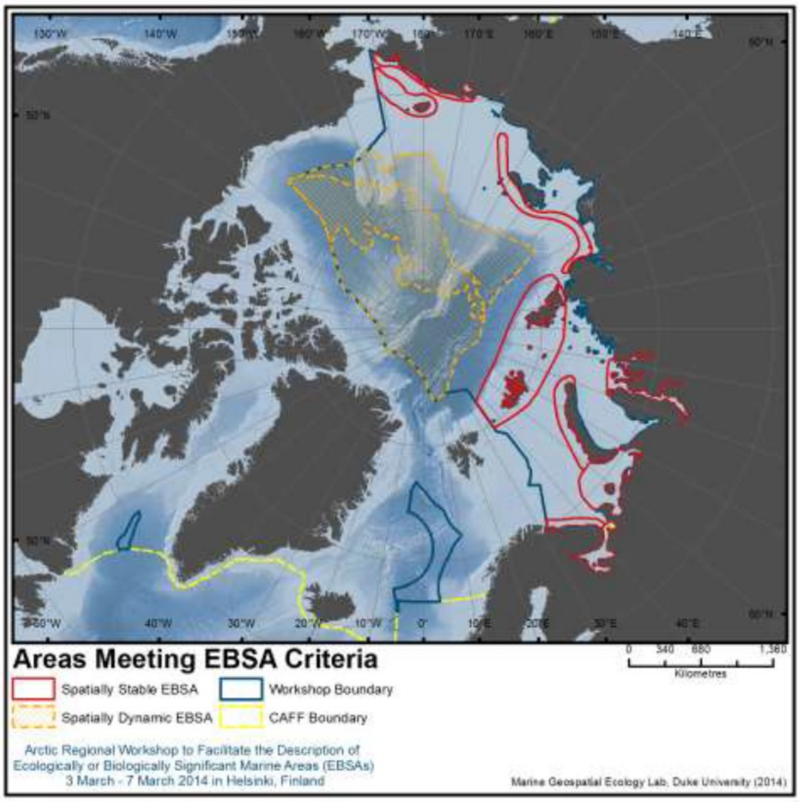

Figure 3.4. Areas meeting the EBSA criteria in the Arctic Ocean[117].

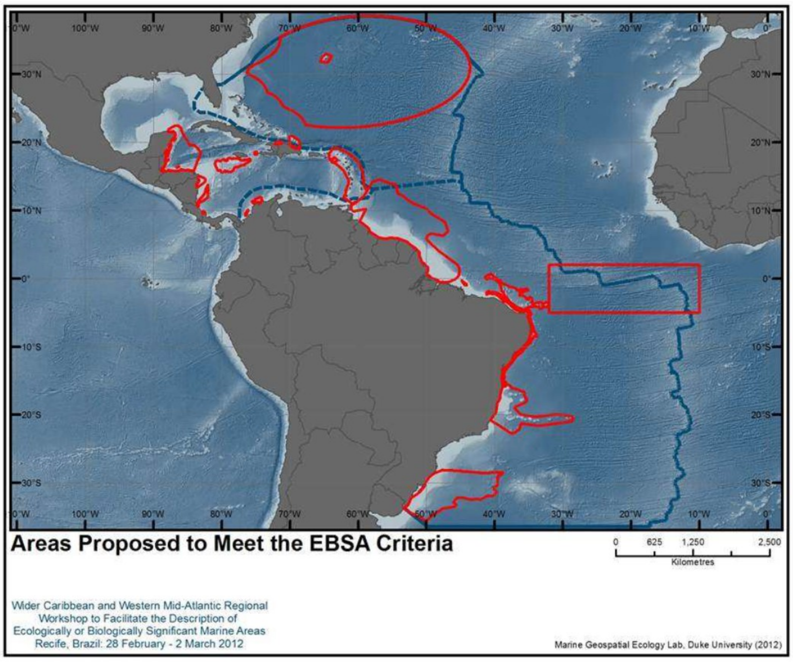

Figure 3.5. Areas meeting EBSA criteria in the Wider Caribbean and Western Mid-Atlantic Region.

For the Wider Caribbean and Western Mid Atlantic (Figure 3.5.), only one EBSA - the Sargasso Sea - borders the North Atlantic region of concern for the ATLAS project[118].

3.4 What next in the EBSAs process?

Describing EBSAs does not imply any obligation in terms of management commitments. However, EBSAs should be considered as 'critical natural capital' and thus may merit additional protective measures by States and competent international organisations. The UNGA still needs to "identify a process to successfully bring forward, designate, and manage MPAs in ABNJ"[119]. While lack of knowledge on marine species and ecosystems may stand in the way of describing and identifying EBSAs, it has not prevented the expansion, real or prospective, of human activities, such as fishing and deep-sea mining[120]. MPAs and other protective measures could be advantageously considered within or encompassing EBSAs, providing protection to the most critical species and ecosystems. Such an approach might arguably appeal to a variety of different stakeholders, by legitimizing some human activities, while preventing their future encroachment on vulnerable ecosystems[121].

Concerning the NE Atlantic, it is somewhat ironic that in the one region where a suite of MPAs has been agreed, the EBSA descriptions, intended to stimulate consideration of MPAs and other measures, have not been formally submitted to the CBD process for ratification[122]. This impasse, effectively imposing a political perspective on what should be a purely scientific and technical exercise, is further complicated as those States unable to agree (Parties to both OSPAR and NEAFC) have differing reasons for objecting. Arguments advanced, such as lack of legal certainty, have several parallels with the CGFZ MPA negotiations and resolution will need to involve trust building between ministries within the Contracting Parties concerned.

4 Vulnerable Marine Ecosystems (VMEs) in the North Atlantic

This chapter highlights the main aspects of Vulnerable Marine Ecosystems (VMEs), synthesising and comparing the main characteristics of VMEs in ABNJ in the N Atlantic.

4.1 The United Nation's process for the protection of VMEs

The VME concept first entered discussions at the United Nations General Assembly (UNGA) in 2002, through Resolution 57/171[123], which called upon States to *i.a.*: i) halt "the loss of marine biodiversity, in particular fragile ecosystems" (para. 51); ii) eliminate destructive fishing practices and establish MPAs, including representative networks by 2012 (para.53); and, iii) protect VMEs (para. 62a)[124] (Box 4.1.).

Box 4.1. What are Vulnerable Marine Ecosystems (VMEs)?

FAO's 2009 International Guidelines for the Management of Deep-sea Fisheries in the High Seas[125] define *Vulnerability* as: "related to the likelihood that a population, community, or habitat will experience substantial alteration from short-term or chronic disturbance, and the likelihood that it would recover and in what time frame. These are, in turn, related to the characteristics of the ecosystems themselves, especially biological and structural aspects."

VMEs can be thought of as marine ecosystems where particular populations, communities or habitats, some of which may be physically or functionally fragile, are easily disturbed or likely to experience substantial alteration from short-term or chronic disturbance, and are very slow to recover, or may never recover.

Vulnerability (either of populations, communities and/or habitats, which may be physically fragile or inherently rare) must be assessed relative to specific threats (such as, in fishing, the type of fishing gear used, or the kind of disturbance experienced). Risks to a marine ecosystem are determined by: i) its vulnerability, ii) the probability of a threat occurring; and iii) the mitigation means applied to the threat[126].

A series of "sustainable fisheries" resolutions began in 2003, starting with Resolution 58/214, which requested an analysis of "current risks to the marine biodiversity of vulnerable marine ecosystems including, but not limited to, seamounts, coral reefs, including cold-water coral reefs and certain other sensitive underwater features, related to fishing activities"[127]. Resolution 59/25[128] called upon states, either individually or through Regional Fisheries

Management Organisations or Arrangements (RFMO/As) (cf. Box 4.2.), to take urgent action including the "interim prohibition of destructive fishing practices" with adverse impacts on VMEs in ABNJ "until such time as appropriate conservation and management measures have been adopted in accordance with international law" (para. 66); it further called upon RFMO/As to adopt conservation and management measures to address the impact of destructive fishing practices with adverse impacts on VMEs, and to ensure compliance with such measures (para. 67) (Box 4.3.).

Box 4.2. What is a Regional Fisheries Management Organisation/Arrangement (RFMO/A)?

According to FAO (2016)[129], an RFMO/A is "an intergovernmental organization through which States or economic entities cooperate in developing, adopting, and implementing conservation and management measures. These measures may often target specific species and ecosystems and are binding for applicable RFMO/A members. There is a range of conservation and management measures that address issues covering: area based measures; adverse environmental impacts; fishing effort; total allowable catch or other allocation mechanisms; data collection; and monitoring, control and surveillance (MCS). The conservation and management measures can be extended to non-members through, for example, international treaties such as the UN Fish Stocks Agreement." (P. 3). Figure 4.1. illustrates the geographical competence areas of regional fishery bodies mandated to manage deep-sea fisheries in ABNJ.

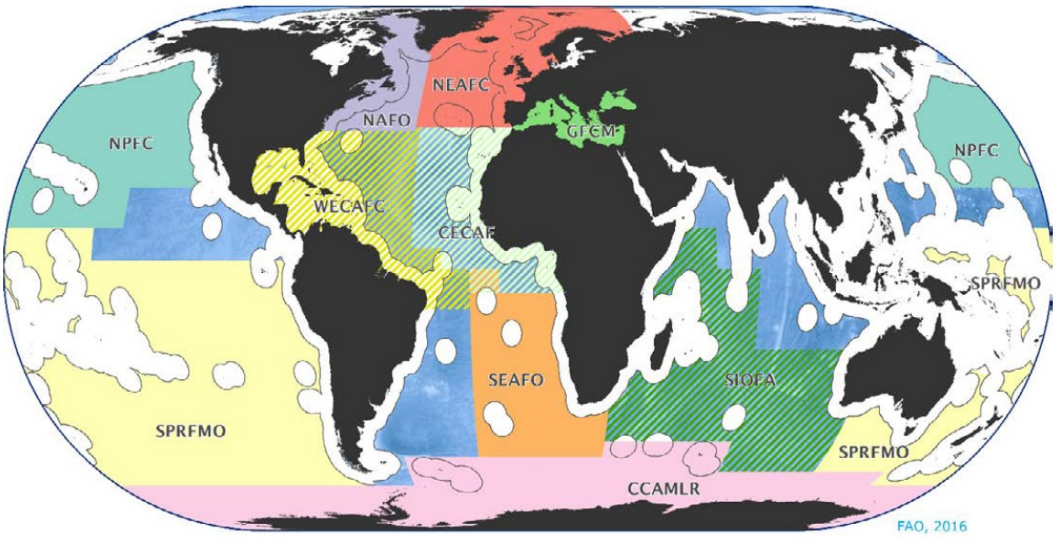

Figure 4.1. Competence areas of RFMO/As mandated to manage deep-sea fisheries in ABNJ (Source FAO, 2016[130])

In 2006, Resolution 61/105 called upon states to "take action immediately (…), to sustainably manage fish stocks and protect VMEs, including seamounts, hydrothermal vents and cold water corals, from destructive fishing practices, recognizing the immense importance and value of deep sea ecosystems and the biodiversity they contain" (para. 80). The Resolution further stipulated that such action should be carried out individually and/or through RFMO/As and be consistent with the precautionary and ecosystem approaches, and it called on RFMO/As to adopt and implement such measures no later than 31 December 2008 (para. 83)[131].

Box 4.3. Defining deep-sea fisheries and significant adverse impacts[132,133,134]

Deep-sea fisheries (DSFs): fisheries, usually between 200-2000 m (on the continental shelf or isolated typographical features such as seamounts, ridge systems and banks), in which: i) the total catch includes species that can only sustain low exploitation rates (due to particular life cycle characteristics, such as slow growth and maturation, intermittent spawning and recruitment, long life expectancies and low natural mortality rates); and ii) the gear is likely to contact the sea floor during the normal course of fishing.

Significant adverse impacts (SAIs): those that compromise ecosystem integrity (*i.e.* structure or function) on more than a temporary basis (*i.e.* recovery >5-20 years), such that: i) affected populations are unable to replace themselves; ii) long-term natural productivity of habitats is degraded; or iii) significant loss of species richness, habitat or community types occurs. Impacts should be evaluated (individually, in combination and cumulatively) based on: i) intensity or severity; ii) spatial extent of impact relative to the availability of the habitat type affected; iii) sensitivity/vulnerability of the ecosystem to the impact; iv) ability of the ecosystem to recover, and its recovery rate; v) extent to which the impact may alter ecosystem functions; and vi) impact timing and duration.

In 2009, the Food and Agriculture Organization of the United Nations (FAO) published a set of international guidelines for the management of deep-sea fisheries in the High Seas[135]. These FAO guidelines included a set of five criteria to assist RFMO/As and States in identifying VMEs (Table 4.1.), based on the best available scientific knowledge and expert judgement. They have since been used by RFMO/As in the development of measures to protect VMEs, to sustainably manage bottom fisheries by reducing the risk of significant adverse impacts[136].

Following GA direction, FAO has produced a VME database (online at http://www.fao.org/in-action/vulnerable-marine-ecosystems/en/) that shows the history and current status of areas closed to protect VMEs as well as links to the associated scientific and management documentation supporting the decisions.

Table 4.1. List of characteristics to be used as criteria for the identification of Vulnerable Marine Ecosystems.[137]

Criterion	Definition
Uniqueness or rarity	Area or ecosystem that is unique or contains rare species whose loss could not be compensated for by similar areas or ecosystems, including: habitats that contain endemic species; habitats of rare, threatened or endangered species that occur only in discrete areas; or nurseries or discrete feeding, breeding, or spawning areas.
Functional significance of the habitat	Discrete areas or habitats necessary for the survival, function, spawning/ reproduction or recovery of fish stocks, particular life history stages (*e.g.* nursery grounds or rearing areas), or of rare, threatened or endangered marine species.
Fragility	Ecosystem that is highly susceptible to degradation by anthropogenic activities
Life-history traits of component species that make recovery difficult	Ecosystems characterized by populations or species' assemblages with slow growth rates; late age of maturity; low or unpredictable recruitment; or long-lived.
Structural complexity	Ecosystem characterized by complex physical structures created by significant concentrations of biotic and abiotic features, often with high diversity, dependent on the structuring organisms, and where ecological processes are usually highly dependent on these structured systems.

4.2 VMEs vs. EBSAs

VMEs have a different governance structure to EBSAs. VME areas are identified on the basis of the co-location between the vulnerable species and habitats and the current or potential threat from one pressure, fishing. The roles of science, mitigation actions and reporting are all embodied in the GA resolutions with the responsibilities of flag states, RFMO/As and FAO clearly stated. In particular, managers have actively sought scientific advice in order to fulfil the intent of the resolution. Identification guidelines for VMEs, produced in the context of sustainable deep sea fishing practices by FAO, include standards and criteria for identifying VMEs in ABNJ and identifying the potential impacts of fishing activities from bottom contact fishing gears. By referring explicitly to bottom contact gears it also means that most VMEs are benthic features that occur in less than 2000 m water depth, such as coral and sponge grounds, cold seeps, hydrothermal vents and so on.

The identification criteria for VMEs are highly consistent with those of EBSAs except for the EBSA naturalness criterion, which has no direct parallel in the VME identification guidelines. The EBSA productivity criterion could be applicable to VME identification if this aspect of the habitat had functional significance for fish or threatened species. Consequently, it could be expected that all VME areas would be considered EBSAs but not all EBSAs VMEs, however, this is not the case due to one major difference in designation: VME areas can be identified as areas that are known to occur or are likely to occur based on the best available scientific information. Therefore many topographic features, referred to as VME elements, such as seamounts and canyons have been designated VMEs on the *likelihood* of VME species and habitats being present and the possibility of fishing causing damage to them. The CBD EBSA proforma requires much more scientific support for designation and we see examples, *e.g.*, in the northwest

Atlantic, where seamount areas such as the Fogo and Newfoundland Seamounts identified as VMEs by NAFO, were too data deficient for inclusion as CBD EBSAs.

FAO have conducted regional workshops to facilitate the identification of VMEs and when possible planned those meetings back to back with the CBD regional workshops on EBSAs to facilitate data and knowledge sharing. In the North Atlantic, VME designation preceded EBSA identification (still ongoing) and in the northwest Atlantic the VME areas were considered by the CBD regional EBSA workshop.

Areas closed to protect VMEs by RFMO/As are generally bounded by boxes or polygons that protect the features, whilst maintaining simplistic co-ordinates for fishers and enforcement. This contrasts with many of the CBD EBSAs, which follow closely the physical boundaries of the areas. This can account for the aerial differences in location when both processes have identified the same feature.

4.3 RFMO/As in the North Atlantic

The area relevant to the ATLAS project, in the North Atlantic, falls mainly under the jurisdiction of two RFMO/As: the Northwest Atlantic Fisheries Organization (NAFO) and the North East Atlantic Fisheries Commission (NEAFC).

4.3.1 The Northwest Atlantic Fisheries Organization (NAFO)

The Northwest Atlantic Fisheries Organization (NAFO) was founded in 1979 building on a previous structure, and has 12 contracting parties (Canada, Cuba, Denmark (in respect of Faroe Islands and Greenland), France (in respect of St. Pierre and Miquelon), Iceland, Japan, Norway, Republic of Korea, Russian Federation, Ukraine, the USA, and the EU, representing several fishing nations). The NAFO Convention Area includes Baffin Bay and the Davis Strait, and stretches south to the latitude of Cape Hatteras at 35°N and east to the 42°W meridian (Figure 4.1). The NAFO regulatory area (NRA) is that part of the convention area outside the national 200 nm EEZs in ABNJ. Stocks wholly within EEZs are managed by the respective coastal State(s), and straddling stocks are managed cooperatively with the pertinent coastal State(s).

NAFO's structure is made up of a General Council (GC), a Scientific Council (SC), and a Fisheries Commission (FC). The Scientific Council provides scientific advice and furthers scientific knowledge relating to the fish stocks, fisheries, and associated ecosystems. The SC Working Group on the Ecosystem Approach to Fisheries Management (WGEAFM) was formed in 2008 to provide guidance to SC on specific ecosystem-related issues and provided much of the scientific advice on VMEs.

Figure 4.1. NAFO convention and regulatory areas.

In 2013 this working group changed its name to the Working Group on Ecosystem Science and Assessment (WGESA). The FC develops and adopts regulatory measures for controlling the fisheries. In 2008 an *ad hoc* FC Working Group of Fishery Managers and Scientists (FCWG FMS-VME) was established to consult with SC and provide recommendations to FC on protection for VMEs. In 2013 a joint FC-SC Working Group on Ecosystem Approach to Fisheries Management was created that reports to both FC and SC. This joint science/manager working group (FCWG FMS-VME /FC-SCWG EAFM) has been instrumental in implementing the UNGA 61/105 in a timely fashion.

NAFO works collaboratively with NEAFC and FAO, alongside other RFMOs, in diverse areas. NAFO also has a long-standing relationship with the International Council for the Exploration of the Seas (ICES), participating in a joint working group on VMEs (WGDEC) and another one on deep water stock assessments (WGDEEP) as well as specific stock assessment groups (*e.g.*, salmon). In 2014, NAFO's Scientific Council was represented at the 2014 CBD EBSA workshop, which described EBSAs in ABNJ in the NW Atlantic region. The Sargasso Sea Commission, established in 2014, is an observer to NAFO, as part of the Sargasso Sea overlaps with the NAFO Convention Area.

4.3.2 The North East Atlantic Fisheries Commission (NEAFC)

The North East Atlantic Fisheries Commission (NEAFC), established in 1959 under the United Nations Convention on the Law of the Sea (UNCLOS), is comprised of five Contracting Parties that have ratified the Convention on Multilateral Cooperation in North-East Atlantic Fisheries (Denmark in respect of the Faroe Islands and Greenland, the EU, Iceland, Norway, and the Russian Federation), and five Cooperating Non-Contracting Parties (Bahamas, Canada, Liberia, New Zealand, and St. Kitts and Nevis). NEAFC adopts management measures for fish stocks, control measures to ensure that those management measures are properly implemented, and measures to protect other parts of the marine ecosystem from potential adverse impacts by fisheries. NEAFC can adopt legally-binding measures for the conservation and management of fisheries resources in all parts of its Convention Area, but focuses largely on the ABNJ portions of the Convention Area (Regulatory Area) (Figure 4.2.).

NEAFC does not have an established internal scientific body but receives scientific information and advice from the International Council for the Exploration of the Seas (ICES), an independent global intergovernmental science organization established in 1902 that conducts and facilitates scientific research and assessments and provides advice to support sustainable ocean use. The Joint NAFO/ICES Working Group on Deepwater Ecology (WGDEC) has been the primary WG within ICES providing expertise on VMEs. Within NEAFC, the Permanent Committee on Management and Science (PECMAS) drafts requests for advice from ICES and provides advice to the Commission on the likelihood of significant adverse impact on vulnerable marine ecosystems (VMEs) of proposals for exploratory bottom fisheries in the Regulatory Area, amongst other responsibilities.

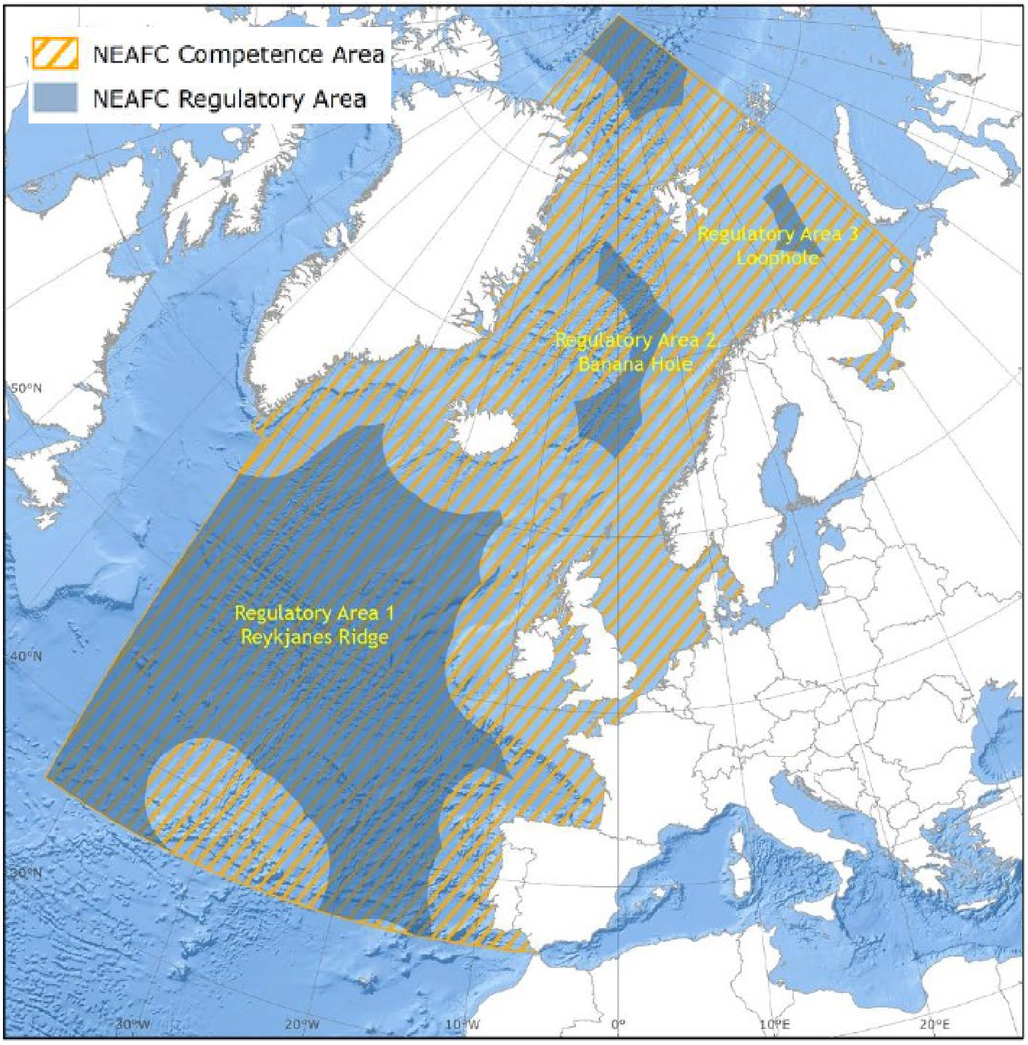

Figure 4.2. NEAFC Competence and regulatory Areas in the NE Atlantic.

NEAFC collaborates with NAFO, and all NEAFC Contracting Parties are parties of NAFO. Some NEAFC Contracting Parties are also members of OSPAR, and both organisations cooperate in the context of area-based management. Bilateral initiatives to formalise cooperation among all relevant international organizations operating in the NE Atlantic Ocean, either focusing on specific species groups (ICCAT, IWC, NAMMCO, NASCO) or specific activities (IMO, ISA), have been developed in recent years.

4.4 VMEs in the North Atlantic

4.4.1 VMEs in the NW Atlantic

Table 4.2. lists the specific VME indicator species (taxa) and elements adopted by NAFO.

Table 4.2. VME indicator species (taxa) and indicator elements adopted by NAFO in 2017[138]

VME Indicator Species Group[139]	Known Taxa	List of Physical VME Ind. Elements	Examples
Large-sized sponges	*Iophon piceum* *Stelletta normani* *Stelletta* sp. *Stryphnus ponderosus* *Axinella* sp. *Phakellia* sp. *Esperiopsis villosa* *Geodia barretti* *Geodia macandrewii* *Geodia phlegraei* *Mycale (Mycale) lingua Thenea muricata* *Polymastia* spp. *Weberella bursa* *Weberella* sp. *Asconema foliatum* *Craniella cranium*	Seamounts	Fogo Seamounts (Div. 3O, 4Vs) Newfoundland Seamounts (Div. 3MN) Corner Rise Seamounts (Div. 6GH) New England Seamounts (Div. 6EF)
Stony corals (known seamount species may not occur in abundance in the NRA)	*Lophelia pertusa* *Solenosmilia variabilis* *Enallopsammia rostrata* *Madrepora oculata*	Canyons	Shelf-indenting canyon; Tail of the Grand Bank (Div. 3N) Canyons with head > 400 m depth; South of Flemish Cap and Tail of the Grand Bank (Div. 3MN) Canyons with heads > 200 m depth; Tail of the Grand Bank (Div. 3O)
Small gorgonian corals	*Anthothela grandiflora* *Chrysogorgia* sp. *Radicipes gracilis* *Metallogorgia melanotrichos* *Acanella arbuscula* *Acanella eburnea* *Swiftia* sp. *Narella laxa*	Knolls	Orphan Knoll (Div. 3K) Beothuk Knoll (Div. 3 LMN)
Large gorgonian corals	*Acanthogorgia armata* *Iridogorgia* sp. *Corallium bathyrubrum* *Corallium bayeri* *Keratoisis ornata* *Keratoisis* sp. *Lepidisis* sp. *Paragorgia arborea* *Paragorgia johnsoni* *Paramuricea grandis* *Paramuricea placomus* *Paramuricea* spp. *Placogorgia* sp. *Placogorgia terceira* *Calyptrophora* sp. *Parastenella atlantica* *Primnoa resedaeformis* *Thouarella grasshoffi*	Southeast Shoal	Tail of the Grand Bank Spawning grounds (Div. 3N)
Sea pens	*Anthoptilum grandiflorum* *Funiculina quadrangularis* *Halipteris* cf. *christii* *Halipteris finmarchica* *Halipteris* sp. *Kophobelemnon stelliferum* *Pennatula aculeata* *Pennatula grandis* *Pennatula* sp.	Steep flanks > 6.4°	South and Southeast of Flemish Cap. (Div. 3LM)

VME Indicator Species Group[139]	Known Taxa	List of Physical VME Ind. Elements	Examples
	Distichoptilum gracile *Protoptilum* sp. *Umbellula lindahli* *Virgularia* cf. *Mirabilis*		
Tube-dwelling anemones	*Pachycerianthus borealis*		
Erect bryozoans	*Eucratea loricata*		
Sea lilies (Crinoids)	*Trichometra cubensis* *Conocrinus lofotensis* *Gephyrocrinus grimaldii*		
Sea squirts	*Boltenia ovifera* *Halocynthia aurantium*		

Table 4.3. lists the VMEs in the NW Atlantic. The distribution and spatial coverage of VMEs in the NW Atlantic is shown in Figure 4.3. The main characteristics of each VME are described separately in Annex IV in tables IV.1 to IV.16 and compared in Table 4.4. Similar VMEs (*e.g.,* Northern Flemish Cap 7, 8, and 9) were grouped together for simplicity. NAFO has provided effective protection for sponges, large and small gorgonian corals and sea pens within its fishing footprint by closing areas to protect VMEs. All VME indicator species groups (Table 4.2) are protected by one or other closures. The steep slopes of the south Flemish Cap are known to contain VME indicator species and have not been protected, however the topography of the area makes it unlikely that it will be fished in the near future[140].

Table 4.3. VMEs in the NW Atlantic.

Inventory ID	Name
VME_NAFO_1/2	Fogo Seamounts 1 and 2
VME_NAFO_3	Orphan Knoll
VME_NAFO_4	Corner Rise Seamounts
VME_NAFO_5	Newfoundland Seamounts
VME_NAFO_6	New England Seamounts
VME_NAFO_7	3O Coral Closure
VME_NAFO_8	Tail of the Bank 1
VME_NAFO_9	Flemish Pass/Eastern Canyon 2
VME_NAFO_10	Beothuk Knoll 3
VME_NAFO_19	Beothuk Knoll 13
VME_NAFO_11/21	Eastern Flemish Cap 4 and 14
VME_NAFO_12	Northeast Flemish Cap 5
VME_NAFO_13	Sackville Spur 6
VME_NAFO_14/15/16	Northern Flemish Cap 7, 8, and 9
VME_NAFO_17/18/24	Northwest Flemish Cap 10, 11, and 12

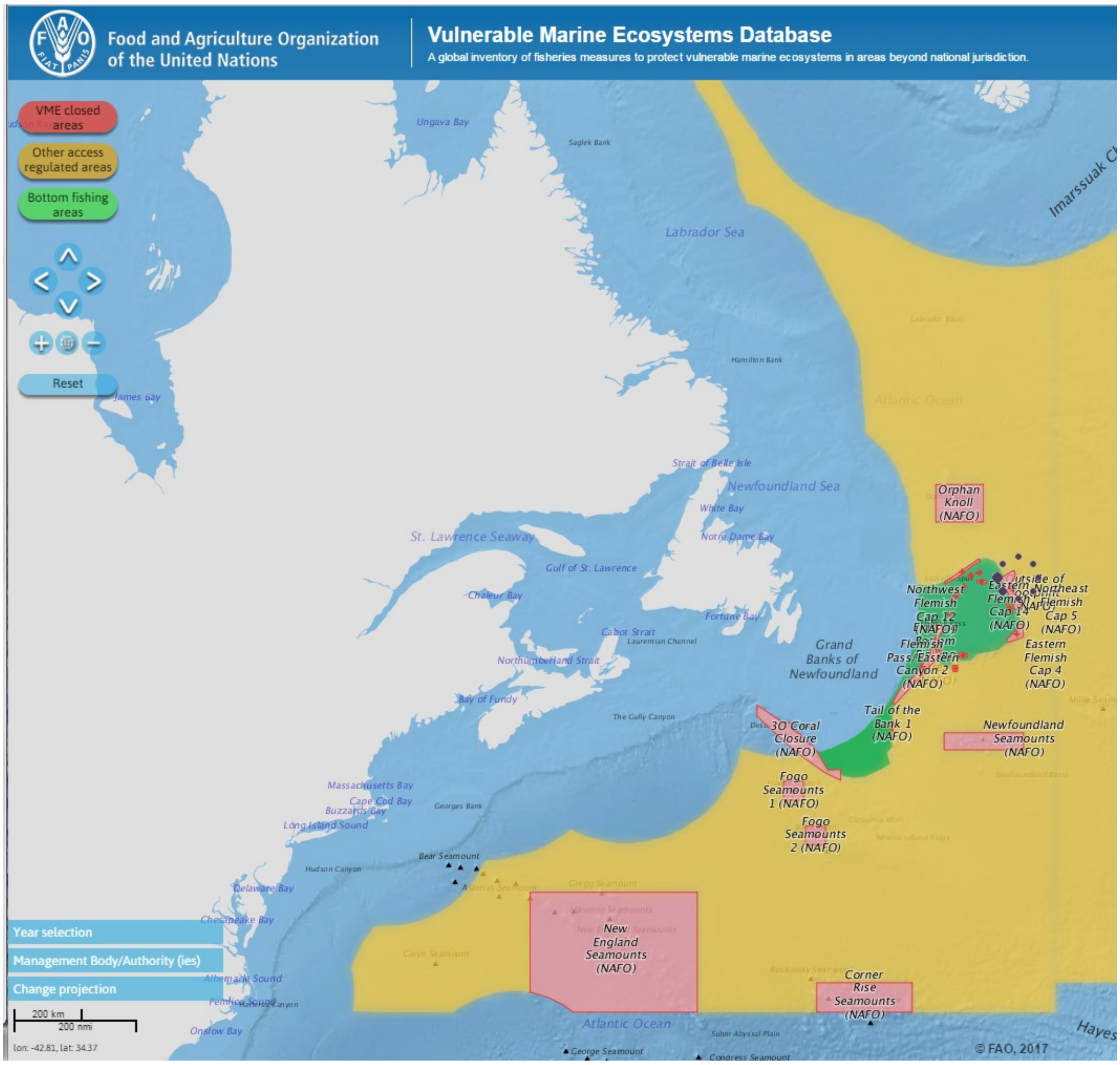

Figure 4.3. Map of VMEs and other regulatory areas in the NW Atlantic.

Table 4.4. NAFO VMEs.

VME Name	Fogo seamounts 1/2	Orphan Knoll	Corner rise seamounts	Newfoundland seamounts	New England seamounts	3O Coral closure	Tail of the Bank 1	Flemish Pass/Eastern Canyon 2
Location	41ºN,52ºW	51ºN,46ºW	35ºN,50ºW	44ºN,45ºW	37ºN,60ºW	43ºN,53ºW	44ºN,48ºW	46ºN,47ºW
Physical description	Seamounts deeper than 2000m	Knoll peaking at 1800 m	Seamounts rising to 1000m	Seamounts deeper than 2400m	Seamounts	Continental slope from 800 m. Mostly soft bottoms with rocky outcrops	Canyon, shoal, around 2000m	Canyon, shoal (<150 m deep at center). Complex hydrography
General biology	High probability of containing VMEs	Biologically rich and complex, incl. corals and sponges	Pristine coral areas. High fish diversity	Xenophyophores	Coral and other hard bottom VME indicators	Likely occurrence of corals: sea pens and small gorgonians	Sponge grounds and likely occurrence of corals, cerianthids, sea squirts, echinoids.	Extensive sponge grounds with associated high spp. diversity
VME Criteria	Seamounts	Knoll	Seamount	Seamount	Seamount	Seapens, Gorgonians, Cerianthids	Sponges	Sponges, large gorgonians and sea pens in N part
Area type	Seamount closure	Seamount closure	Seamount closure	Seamount closure	Seamount closure	Coral closure	Higher sponge/coral concentration	higher sponge/coral concentration
Begin/End date	31.12. 08; 30.12.20	31.12.06; 30.12. 20	31.12.06; 30.12. 20	31.12.06; 30.12. 20	01.01.07; 31.12. 20	31.12.07; 30.12. 20	31.12.09; 30.12. 20	31.12.09; 30.12. 20
Specific measures	No bottom fishing	No bottom fishing	No bottom fishing	No bottom fishing	No bottom fishing	No bottom fishing	No bottom fishing	No bottom fishing

Table 4.4. (contd.) NAFO VMEs.

VME Name	Beothuk knoll 3	Beothuk knoll 13	Eastern Flemish Cap 4	Northeast Flemish Cap 5	Sackville Spur 6	North Flemish Cap 7, 8, 9	Northwest Flemish Cap 10, 11, 12	E Flemish Cap 14
Location	45ºN,46ºW	46ºN,45ºW	46ºN,43ºW	48ºN,43ºW	49ºN,46ºW	48ºN,45ºW	48ºN,45ºW	46ºN,44ºW
Physical description	Knoll	Knoll, steep flanks and canyons with heads > than 400 m	Canyon, slope. Plateau, < 150 m deep in the center. High bottom complexity	Canyon, slope. Plateau, < 150 m deep in the center. High bottom complexity. Steep flanks	Elongate sediment drift feature. The S flank slopes to 900 m in the Flemish Pass; its steeper N flank extends to the floor of the Orphan Basin at 2500 m	Canyon, slope. Plateau, < 150 m deep in the center. High bottom complexity.	Canyon, slope. Plateau, < 150 m deep in the center. High bottom complexity.	Canyon, slope
General biology	Sponge ground VME	Large gorgonians and sponges	Large gorgonian corals and sponge grounds (structure forming). Cerianthids and high densities of stalked crinoids.	Vertical gradient of benthic communities: coral dominated at ~2450 m, corals intermixed with sponges c. 2000 m, sponge dominated grounds at 1500 m, and diverse community of corals, sponges and other benthic taxa at ~1300 m.	Extensive sponge grounds from 1300 m - 1800 m. Demosponges dominate in shallower water. Geodiids occur in deeper water. These sponge grounds host a high diversity and abundance of associated megafaunal spp.	high concentration locations of seapen VME system.	high concentration locations of seapen VME system.	Area closed to protect sea pens
VME Criteria	Knoll; Sponges	Knoll; Sponges, large gorgonians	Sponges, large gorgonians, cerianthids	Sponge	Sponge	Sea pen system	Sea pen system	Sea pen system
Area type	Sponge VMEs	Sponges, large gorgonian VMEs	Sponges, large gorgonians, cerianthids VMEs	Sponge VME	Sponge VME	Sea pen VME	Sea pen VME	Sea pen VME
Begin/End date	31.12.09; 30.12. 20	31.12.14; 30.12. 20	31.12.09; 30.12. 20	31.12.09; 30.12. 20	31.12.09; 30.12. 20	31.12.09; 30.12. 20	All closed until 30.12. 20	31.12.16; 30.12. 18
Specific measures	No bottom fishing	No bottom fishing	No bottom fishing	No bottom fishing	No bottom fishing	No bottom fishing	No bottom fishing	No bottom fishing

4.4.2 VMEs in the NE Atlantic

Table 4.5. lists the specific VME indicator species (taxa) and elements adopted by NEAFC in 2014[141].

Table 4.5. NEAFC VME indicator species (taxonomic groups) and elements.

VME Habitat Type	Known Taxa	List of Physical VME Indicator Elements	Examples
Cold-water coral reef	*Lophelia pertusa* *Solenosmilia variabilis*	Isolated seamounts	Non- Mid-Atlantic Ridge seamounts
Hard-bottom coral garden	Anthothelidae Chrysogorgiidae Isididae, Keratoisidinae Plexauridae Acanthogorgiidae Coralliidae Paragorgiidae Primnoidae Schizopathidae	Steep-slopes and peaks on mid-ocean ridges	Steep ridges and peaks support coral gardens and other VME species in high density: Mid-Atlantic Ridge
Soft-bottom coral gardens	Chrysogorgiidae Caryophylliidae Flabellidae Nephtheidae	Knolls	A typographic feature that rises less than 1000 m from the seafloor: Hatton Bank, Fangorn Bank
Deep-sea sponge aggregations	Geodiidae Ancorinidae Pachastrellidae Axinellidae Mycalidae Polymastiidae Tetillidae Rossellidae Pheronematidae	Canyon-like features	A steep sided 'catchment' feature not necessarily associated with a shelf, island or bank margin: Loury Canyon, margin of Edora's Bank
Seapen fields	Anthoptilidae Pennatulidae Funiculinidae Halipteridae Kophobelemnidae Protoptilidae Umbellulidae Vigulariidae	Steep flanks >6.4°	SE Rockall
Tube-dwelling anemone patches	Cerianthidae		
Mud- and sand-emergent fauna	Bourgetcrinidae Antedontidae Hyocrinidae Xenophyophora Syringamminidae		
Bryozoan patches			

NEAFC requested ICES to review the VME Indicator Species identified in NAFO to see if they were applicable to the NE Atlantic. ICES found that at the family level there was a good match between the two lists but noted that the NE Atlantic has taxa not found in the NW Atlantic. NEAFC also accepted additional taxa (Flabellidae, Nephtheidae) that when examined by NAFO, were found not to meet the criteria identified in the FAO guidelines. This could be due to differences in the densities and/or species composition of these solitary cup corals and soft corals and/or by a desire to match habitat types with the OSPAR List of Threatened and/or Declining Species and Habitats.

Table 4.6. lists the VMEs in the NW Atlantic. The distribution and spatial coverage of VMEs in the NW Atlantic is shown in Figure 4.4. The main characteristics of each VME are described separately in Annex V in tables V.1 to V.13 and compared in table 4.7.

Table 4.6. VMEs and other regulatory areas in the NE Atlantic.

Inventory ID	Name
VME_NEAFC_1/38	Hatton Bank 1 and 2
VME_NEAFC_2	NW Rockall
VME_NEAFC_3	SW Rockall Area 1 (Empress of Britain Bank)
VME_NEAFC_4	Logachev Mounds
VME_NEAFC_5	West Rockall Mounds
VME_NEAFC_9	Altair
VME_NEAFC_10	Antialtair
VME_NEAFC_12	Northern MAR Area
VME_NEACF_13	Middle MAR Areas (Charlie Gibbs Fracture Zone and Subpolar frontal region)
VME_NEAFC_14	Southern MAR Area
VME_NEAFC_15	Edora Bank
VME_NEAFC_16/17	SW Rockall Area 2 and 3
VME_NEAFC_6	Hecate Seamount
VME_NEAFC_7	Faraday Seamount
VME_NEAFC_8	Reykjanes Ridge
VME_NEAFC_34	Rockall Bank
VME_NEAFC_36	SW Rockall Bank
VME_NEAFC_37	Hatton-Rockall Basin

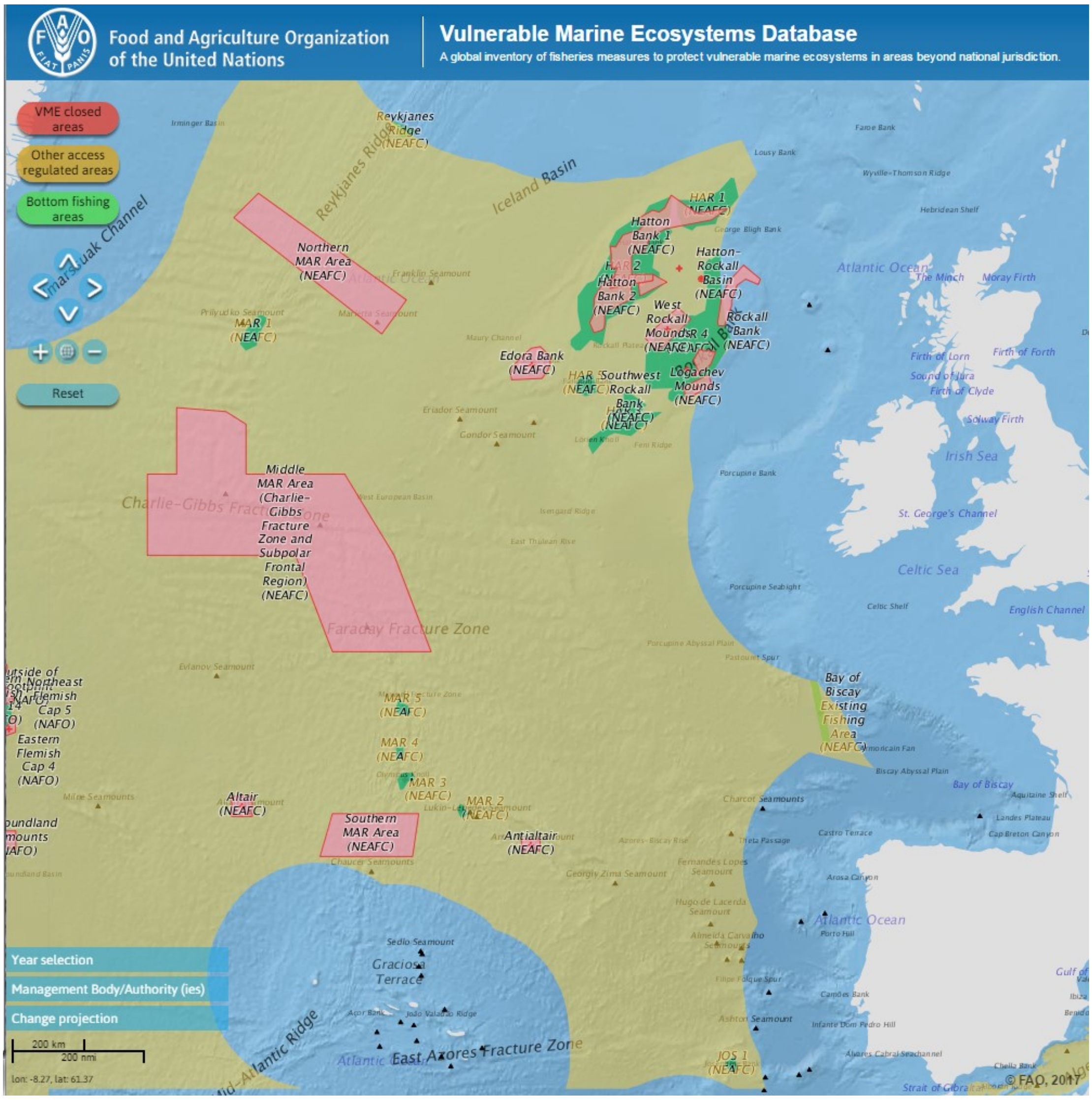

Figure 4.4. Map of VMEs and other regulatory areas in the NE Atlantic.

Table 4.7. NEAFC VMEs.

VME Name	Northern MAR Area	Middle MAR Area	Southern MAR Area	Altair Seamount	Antialtair seamount	Hatton Bank	Rockall Bank
Location							
Physical description	One contiguous VME element; complex topography, incl. the axial valley and flanks with hills and valleys of various depths and configurations and many steep and seamount-like structures	CGFZ and sub-Polar Region. One contiguous VME element with complex topography, comprising the axial valley and flanks with hills and valleys of various depths and configurations and including many steep and seamount-like structures.	One contiguous VME element; complex topography, incl. the axial valley and flanks with hills and valleys of various depths and configurations and many steep and seamount-like structures	Isolated seamount W of the MAR north of the Azores.	NE of the Azores EEZ. Antialtair is older than the seamounts of the MAR, which is still an active seafloor spreading centre.	Large, elongate and arc-shaped volcanic bank, stretching nearly 500km, forming a topographic high rising from surrounding deep water (depths ranging from < 500m to > 1000m).	Shallow bank (65-220m). A small pinnacle – the island of Rockall – breaks the surface toward the N end of the Bank. Seabed changes from low rock ridges and boulder fields covered in coarse sand to a complete cover of fine sand.
General biology	mapping of individual VME elements has not been attempted due to structural complexity	mapping of individual VME elements has not been attempted due to structural complexity	mapping of individual VME elements has not been attempted due to structural complexity	Considered a near-pristine example of oceanic seamount ecosystem, likely to contain unique spp., as well as important concentrations of wide range of fish and corals.	Due to seamount's age, likely occurrence of a greater number of endemic spp. in comparison to MAR Seamounts.	Hard substrata (boulders, cobbles and bedrock reef) support diverse epifauna, incl. corals, gorgonian sea fans, sponges, incl. glass sponges; sessile sea cucumbers, anemones and brachiopods.	Seabed colonised by discrete patches of *Lophelia pertusa*, (fairly common at 130 - 400m deep). Confirmed occurrence of coldseep habitats (bacterial mats, fluid vents) and coral gardens.
VME Criteria	Steep-slopes and peaks on mid-ocean ridges; Protection of coldwater corals.	Steep-slopes and peaks on mid-ocean ridges; Protection of coldwater corals.	Steep-slopes and peaks on mid-ocean ridges; Protection of coldwater corals.	Isolated seamounts	Isolated seamounts	Knolls; Protection of coldwater corals and sponges.	Steep flanks >6.4º; Protection of coldwater corals and sponges.
Area type	Area closures for the protection of VMEs	Area closures for the protection of VMEs	Area closures for the protection of VMEs	Area closures for protection of VMEs	Area closures for the protection of VMEs	Closures on Hatton and Rockall Banks	Closures on Hatton and Rockall Banks
Begin/End date	2009-2017	2009-2017	2009-2017	2009-2017	2009-2017	2009-2017	2009-2017
Specific measures	1) Closed to bottom trawling and fishing with static gear, 2) gillnets banned; actions against ghost fishing and lost gear in place. 3) Authorization to go to new fishing areas follows a strict exploratory fishing protocol.	Closed to bottom trawling and fishing with static gear, incl. bottom set gillnets and long-lines, including CGFZ and Subpolar frontal zone.	1) Closed to bottom trawling and fishing with static gear, 2) gillnets banned; actions against ghost fishing and lost gear in place. 3) Authorization to go to new fishing areas follows a strict exploratory fishing protocol.	Closed to bottom fishing since 2009. Closures will be reviewed in 2017.	Closed to bottom fishing since 2009. Closures will be reviewed in 2017.	Bottom trawling and fishing with static gear, including bottom set gillnets and long-lines is prohibited. Areas will be reviewed in 2017.	Bottom trawling and fishing with static gear, including bottom set gillnets and long-lines is prohibited. Areas will be reviewed in 2017.

Table 4.7. (contd.) NEAFC VMEs.

VME Name	**Logachev Mounds**	**West Rockall Mounds**	**Edora's Bank**	**Southwest Rockall Bank**	**Hatton-Rockall Basin**	**Hatton Bank 2**
Location						
Physical description	Closely spaced carbonate mounds (500-1200 m), some very steep-sided, up to 350 m high and 2 km wide at the base, consisting of muds, mainly aragonite, with live and/or dead cold-water corals and buried dead corals. Shelly sands found between the mounds.	Carbonate mounds.	SW of Hatton Bank. Area of unusually complex terrain and high rugosity. Bank has a distinct moat around the base, allowing its demarcation as geomorphologic feature.	Shallow bank (depths ranging 220m - 65m), though a small pinnacle – the island of Rockall – breaks the surface toward the northern end of the Bank. Seabed changes gradually: from low rock ridges and boulder fields covered in coarse sand to a cover of fine sand.	Large (c. 800 km by 150 km) sedimentary basin to the W of Ireland and the UK beneath the major deepwater area known as the Rockall Trough. Water depth is > 1 km and the muddy sediments support a range of spp. adapted to life at this depth.	Sedimentary seabed that covers much of the SW slopes of the Hatton Bank (Hatton Drift) mainly composed by muddy-sandy deposits.
General biology	Extensive occurrence of deep-water coral reefs mainly, *Lophelia pertusa* and *Madrepora oculata*. Likely occurrence of coral thickets	Extensive occurrence of living deep-water coral reefs mainly of *Lophelia pertusa* and *Madrepora oculata*.	Gorgonian corals, cup corals, soft corals, and coldwater reef building corals; sponges	VME indicators include stony corals, sponges, sea pens, and the occasional black coral.	Unusual aggregations of deep-sea sponges – an OSPAR Threatened and/or Declining habitat.	Area 1: Deep-sea sponges and gorgonians Area 2: Stony coral, gorgonians, sea pens, knoll, carbonate mounds and out-cropped rock
VME Criteria	Canyon-like features (in part); Protection of coldwater coral.	Protection of coldwater coral	Canyon-like features; Protection of coldwater corals and sponges	Protection of coldwater coral	Protection of sponges	Protection of coldwater coral and sponge
Area type	Closures on the Hatton and Rockall Banks	Closures on the Hatton and Rockall Banks 2015	Closures on the Hatton and Rockall Banks 2015	Closures on the Hatton and Rockall Banks 2015	Closures on the Hatton and Rockall Banks 2015	Closures on the Hatton and Rockall Banks 2015
Begin/End date	2009-2017	2009-2017	2009-2017	2009-2017	2009-2017	2009-2017
Specific measures	Bottom trawling and fishing with static gear, incl. bottom set gillnets and long-lines is prohibited. Areas will be reviewed in 2017.	Bottom trawling and fishing with static gear, incl. bottom set gillnets and long-lines is prohibited. Areas will be reviewed in 2017.	Not an existing NEAFC fishing area. Was closed by NEAFC Area 09 2013 Bottom trawling and fishing with static gear, incl. bottom set gillnets and long-lines is prohibited. No end date set for this closure.	Bottom trawling and fishing with static gear, including bottom set gillnets and long-lines is prohibited. Areas will be reviewed in 2017.	Bottom trawling and fishing with static gear, including bottom set gillnets and long-lines is prohibited. The areas will be reviewed in 2017.	Bottom trawling and fishing with static gear, including bottom set gillnets and long-lines is prohibited. Areas will be reviewed in 2017.

5 Expert evaluations

Each of the area-based management tools described in the previous chapters is currently subject to review and scrutiny. These evaluations are largely taking place independently of one another in line with the aims and obligations of the organisations responsible for their designation. This chapter reviews the individual evaluation processes for OSPAR MPAs, CBD EBSAs and FAO VMEs and considers a number of more holistic initiatives relevant to determining priorities for expert assessment.

5.1 OSPAR MPAs: Is OSPAR's network of high seas MPAs ecologically coherent?

In 2007 OSPAR adopted a background document on the ecological coherence of its network of MPAs[142]. It was recognised that "Because ecological coherence is a holistic concept reliant on many constituent parts, it is much easier to develop tests that indicate when it has not been achieved (*i.e.* some of the parts are missing) than it is to test when it has been achieved (*i.e.* when all the parts are present and interacting as expected). Thus, achieving the goal of ecological coherence is one that ultimately cannot be measured exactly, but must rather be stated as a likelihood, based on looking at a broad suite of indicators".[143]

Comprehensive reviews of OSPAR's current network of MPAs[144] suggest that "it is very unlikely to be ecologically coherent"[145], due, *i.a.*, to the uneven spatial distribution of MPAs (including across depth ranges) and to insufficient habitat cover to secure viable populations and ecosystem protection in the long term, allied to insufficiency of scientific knowledge. More certainty is possible in coastal waters where data coverage is available and measures of ecological coherence have yielded encouraging results[146].

OSPAR MPAs in ABNJ were proposed based on data availability and expert knowledge, under the umbrella of the precautionary principle (explicitly endorsed in various international conventions and agreements, such as UNCLOS and OSPAR). It was considered that "even if the inferences are found to be incorrect at a later date, precautionary data-poor management will likely safeguard biodiversity better than the alternative of no management at all"[147]. Ultimately, selected sites represent a compromise between existing information and scientific grounded inferences, and a politically feasibility to put MPAs in place. As such, at present OSPAR's list of high seas MPAs should be considered a set or a collection of sites rather than a 'network' per se.

Improvements towards ecological coherence can, however, be achieved by including new MPAs to fill existing gaps, thus enhancing coverage of features, representativity, connectivity (including viability and adequacy), resilience to multiple stressors, (including climate change and ocean acidification) and management (cf. Box 5.1. with OSPAR principles for assessing the ecological coherence of MPA networks)[148]. Ongoing methodological studies are considering critical elements of success for MPA networks[149]. Along these lines, OSPAR is currently considering proposals to integrate new sites in its network of high seas MPAs.

Box 5.1. OSPAR principles for assessing the ecological coherence of MPA networks (derived from OSPAR, 2006)[150]

Features – MPAs should be designated in areas that best represent the range of habitats, species and ecological processes in the OSPAR Maritime Area. Proportions of features that should be protected by the MPA network may be higher for particularly threatened and/or declining features.

Representativity – MPAs should protected examples of the same features across their known biogeographical extent to reflect known sub-types. EUNIS Level 3 habitats are stated as a potentially useful way of characterising the OSPAR Maritime Area for the purposes of including biogeographic variation in the network.

Connectivity – In the absence of dispersal data, connectivity may be approximated by ensuring the MPA network is well distributed in space. Where scientific understanding is further developed, the MPA network should reflect locations where a specific path between identified places is known (*e.g.* critical areas of a life cycle for a given species).

Resilience – Replication of features in separate MPAs in each biogeographic area is desirable where possible. The appropriate size of a site should be determined by the purpose of the site and be sufficiently large enough to maintain the integrity of the feature(s) for which it is selected.

Management – OSPAR MPAs should be managed to ensure the protection of the features for which they were selected and to support the functioning of an ecologically coherent network.

5.2 CBD EBSAs

Significant activity to review the EBSA process took place during 2016. This is set out below and where relevant, specific Atlantic aspects are highlighted.

5.2.1 Berlin Workshop, February 2016

Firstly, in February 2016 an expert workshop was convened by the Global Ocean Biodiversity Initiative (GOBI) and the CBD Secretariat pursuant to CBD COP12 request in Paragraph 10 of CBD decision XII/22[151]. As a point of departure this workshop took note of comments received by the Executive Secretary to the CBD in December 2015 (following a request to Parties and international organisations). The chair of the meeting set out the following key questions[152]:

- How do we establish a transparent and appropriate process to update and refine individual EBSA descriptions?
- How do we reclassify existing EBSAs into the 4 emerging categories? (cf. Box 5.2.)
- How do we usefully complement EBSA "scientific expert" workshop outcomes with more systematic methods?
- How do we revisit geographic areas or ecological features that may not have been fully considered under past workshops?
- How do we complete our global coverage and reconcile regional gaps and overlaps?
- How do we influence global ocean research agendas and funding to advance this work?

The workshop considered data issues, categorization of EBSAs, EBSA criteria application and retaining EBSA information (including utility of OBIS). More specifically participants suggested the need for:

- Consideration of a systematic approach to deal with new data, and the merits of any theme-based workshops involving appropriate experts;
- More attention to the norms of regional ecosystems;
- Clarity on which datasets used in the description of EBSAs have already been the subject of systematic analysis, and which datasets comprise raw data;
- Consideration of assumptions about completeness and comparability of datasets;
- A more comprehensive analysis of gaps highlighted by the workshops.

In addition specific workshop derived products, such as Arctic multi-year ice and ice edge delineation and incorporation of national perspectives and processes were noted. The workshop observed that "many potential areas that may meet EBSA criteria could not be fully described due to many reasons such as lack of nominated experts for the concerned countries, difficulties in accessing the relevant scientific information, insufficient representation of different expertise, geopolitical constraints, etc."[153].

The workshop concluded that the EBSA process needs to be an open and continuous one as identified by COP decision XI/17. Emphasis was given to the need to link national processes (such as Australia's) and repositories with the CBD EBSA process and Repository. Understanding of the whole EBSA process to describe individual areas is necessary for management, not merely acknowledging the polygons produced by regional workshops. For the North Atlantic it was noted that NAFO Parties had been given an opportunity to revisit and enhance details of relevant fisheries-related protective measures.

Box 5.2. Emerging EBSA categories[154]

Type 1: ***EBSAs characterized by clearly differentiated physical features, fixed in space and time*** (*e.g.* a coral reef or a specific seamount).

Type 2: Similar to type 1, but ***a set of fixed areas sharing similar features and generally clustered in space*** (so as to avoid redundancies and strengthen the information content on the set) (*e.g.* a chain of seamounts or of hydrothermal vents). The description should be done collectively for the set of areas and the mapping would usually illustrate the outer boundary of the set (although within the delineated polygon, there would be a mosaic of some areas not meeting the specified criteria, as well as many patches of area meeting the criteria.)

Type 3: ***Complex EBSAs enclosing a mosaic of constituent sub-areas not stable in space over time***. The outer polygon (larger but fixed) encloses all the area likely to meet the specified criteria "often" (with no tight definition for what "often" means), but how much of the mosaic inside the polygon meets the criteria is in flux (*e.g.*, spawning areas for fish or feeding hotspots for seabirds, dependent on prey availability, seabed substrate, and/or temperature for spawning). The polygons enclose the area where those conditions are particularly likely to be found.

Type 4: EBSAs enclose ***mobile features of the ecosystem*** (*e.g.*, shelf-ice edges and major oceanographic fronts). The location(s) with the combination of features meeting the criteria can be identified more or less homogeneously at any specified time, but the area moves over time. While the description of the area meeting the criteria can be specified, often quite precisely, its coordinates cannot be presented as reliably positioning the EBSAs. Likewise a map has to delineate an area much larger than the feature itself, to represent the full area where it may be encountered at some time during the year.

5.2.2 SBSTTA 20: UNEP/CBD/SBSTTA/20/INF/20

This analysis by the CBD's Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA)[155] built on discussions held in Berlin. More specifically it charted the development of the EBSA process, analysed application of the criteria and noted differences among regional workshops. Discussion of data quality, metadata standards, custodianship of databases and access to data was a recurring theme. In addition the review considered issues of scale, preparation for EBSA workshops, issues of capacity building, incorporating traditional knowledge, evolving approaches using templates and data layers (including inherent strengths and weaknesses) and the relative importance of different criteria and their application. Central tenets were:

- The EBSA process has sought to apply the highest scientific standards for objectivity and evidence-based conclusions based on best available science and taking into account disparity in the scientific capacity among different countries. All criteria are being used and usually in integrated ways; and
- The need to consider how to deal with data poor areas and incorporate other knowledge systems.

The need to categorize EBSAs was stressed. This has been achieved in some regional workshops but not all and has implications for conservation policies and potential management measures. The generally accepted categories are shown in Box 5.2. It was noted that EBSA descriptions often exhibit a combination of features that may make categorization difficult.

The paper concludes that neither the criteria nor the process used to apply them need revision.

Significant attention was given to how to consider new information. In particular:

- How to incorporate improvements or additions to data sets that were used in the scoring of areas against the criteria;
- How to incorporate newly available/accessible scientific information on properties not featured in the workshop scorings;
- How to justify the costs (money, time, preparations) of a full new workshop.

The paper noted the diversity of marine socio-ecological systems and suggested that "the issue of how a changing climate should be considered in application of the EBSA criteria warrants further discussion"[156]. Suggestions put forward were subsequently considered by CBD COP13.

5.2.3 COP13: Decision XIII/12

COP13 provided a political commitment building on these previous two contributions. Specifically in relation to this report, COP13 Decision XIII/12[157]:

- Encouraged North-East Atlantic parties to finalize the ongoing process in that region;
- Invited Parties, such as Canada, who have completed national EBSA-like processes to consider making that information available;
- Welcomed voluntary practical options to enhance the scientific methodology of describing EBSAs (this included categorization);
- Mandated the convening of an expert workshop to:
    - Develop options for modifying EBSAs;
    - Develop options for strengthening the scientific credibility and transparency of the EBSA process including peer review.
- Encouraged sharing of experiences of applying EBSA information;
- Invited Governments and intergovernmental organisations to consider taking appropriate measures to secure the continuing significance of EBSAs;
- Suggested the nomination of marine CBD focal points.

5.3 FAO VMEs

5.3.1 UN deep-sea fisheries review

Rice *et al*. (2014) analysed the FAO criteria for VMEs recognizing that VMEs can meet one or multiple criteria for areas where fishing gear may come into contact with the seafloor. Not dissimilar to Particularly Sensitive Sea Areas (PSSAs, designated in the framework of the International Maritime Organization, IMO), the VMEs are linked directly to management action[158]. As a result, significant areas have been closed to bottom trawling. Whilst recognizing important achievements, Gianni *et al*. (2016) highlighted specific shortcomings including VME areas that remain open to bottom fishing and insufficient 'move-on' rules (the rules that require fishers to cease fishing when they encounter a VME)[159]. A more scientific approach to identifying VMEs in data poor areas would involve predicting the occurrence of VMEs, as demonstrated by habitat suitability modelling creating potential distribution maps for VME indicator taxa carried out *e.g.* by NAFO and Canada[160]. Vulnerability of seamount faunas, many of which are VME 'indicator species', has prompted calls to exclude all seamounts from impacts of deep-sea fishing, recognising them as "islands of rich megafaunal biodiversity in the deep ocean"[161].

A review and evaluation of the implementation of the respective UNGA resolutions on VMEs was coordinated by the UN Division for Ocean Affairs and the Law of the Sea (DOALOS) in 2011, concluding, inter alia, on the need for further impact assessments and cumulative impact assessments to be undertaken to assess and prevent significant adverse impacts (SAIs) on VMEs. A UNGA multi-stakeholder workshop (1-2 August 2016) to consider how the impacts of bottom fishing on VMEs are being addressed preceded another review by the UNGA in November 2016. The ATLAS project was introduced at the stakeholder workshop. On 7 December 2016 the UNGA adopted Resolution 71/123 with both renewed and new calls for actions to manage bottom fisheries on the high seas to protect deep-sea ecosystems and species. Another UNGA review will be held in 2020, a timescale that resonates with the timeframe established for SDG 14.5, as well as with most Aichi Biodiversity Targets.

5.3.2. NAFO's 38th Annual Meeting

In NAFO's 38th Annual Meeting, which took place in Varadero, Cuba, in September 2016, the extension of some VME areas was proposed, namely to ensure continuity between VMEs in national waters and in ABNJ[162].

The Scientific Council considered the development of a work plan for assessment of impacts other than fishing in the NRA (previously requested), to be beyond the SC's capacity and purview, highlighting the complex science and governance issues that would need to be addressed to develop a comprehensive work plan. The SC further emphasized that governance issues are the main impediment for comprehensive protection of VMEs in the NRA, not the scientific knowledge about them[163].

5.3.3. NEAFC's 35th Annual Meeting

During NEAFC's 35th Annual Meeting, which took place in London in September 2016, the protection of VMEs, including corals, continued to be an important issue (NEAFC has already closed bottom fisheries in all areas where VMEs are known to occur or are considered likely to occur according to scientific advice). No changes were made to existing VME measures[164], but emphasis on monitoring, control and compliance was reiterated in the framework of NEAFC's Monitoring, Control and Enforcement System, focusing, *i.a.*, on measures to ensure that bottom fishing only takes place in areas where it is authorised[165].

It is important to recall that NEAFC takes scientific advice from the International Council for the Exploration of the Sea (ICES)[166] (see section 5.10, below). The advice ICES provides to NEAFC effectively constitutes a built-in "peer-review" process to influence priorities for these specific ABMTs.

5.4. CBD's workplan on biodiversity in cold-water areas

Based on the key messages from a scientific review on biodiversity and acidification in cold-water areas[167] CBD's COP13 held in 2016 adopted Decision XIII/11 on a voluntary specific workplan on biodiversity in cold-water areas. This decision recognised, *i.a.*, that "priority areas for protection should include areas that are resilient to the impacts of climate change and thus act as refuges for important biodiversity"[168]. The workplan has 5 objectives:

1. To avoid, minimize and mitigate the impacts of global and local stressors, especially the combined and cumulative effects of multiple stressors;
2. To maintain and enhance ecosystem resilience in cold-water areas contributing to the achievement of Aichi Biodiversity Targets 10, 11 and 15, thereby enabling the continued provisioning of goods and services;
3. To identify and protect refugia sites (including areas capable of acting as refugia sites), and adopt other area-based conservation measures, to enhance the adaptive capacity of cold-water ecosystems;
4. To enhance understanding of cold-water ecosystems, and to understand their vulnerability to different types of stressors and the combined and cumulative effects of various stressors;
5. To enhance international and regional cooperation in support of national implementation, building on existing international and regional initiatives.

Parties are encouraged to undertake the following activities:

- Assess needs and develop integrated policies, strategies and programmes related to biodiversity in cold-water areas;
- Strengthen existing sectoral and cross-sectoral management to address stressors to cold-water biodiversity (including from overfishing and destructive fishing practices, pollution, shipping, seabed mining);
- Develop and apply MPAs and MSP to reduce the impacts of local stressors, and especially the combined and cumulative effects of multiple stressors, on cold-water biodiversity in the context of the ecosystem approach, including throught the identification of EBSAs, VMEs, and PSSAs in cold-water areas;
- Expand and improve monitoring and research on biodiversity in cold-water areas to improve fundamental knowledge of how, and over what time scales, climate change and other human-induced stressors will impact the long-term viability of, and ecosystem services provided by, cold-water biodiversity, habitats and ecosystems;

- Improve coordination and collaboration in research, information sharing and capacity-building to address policy and management needs, and to increase public awareness;
- Identify and provide sustainable sources of financing at the global, regional and national levels to enable the actions outlined in this workplan.

Annex 3 of this Decision stipulated the following monitoring and research needs for supporting the implementation of this workplan:

- Improve knowledge of biodiversity in cold-water areas to provide baseline information used for assessing the effects of climate change and other human-induced stressors;
- Assess the socioeconomic implications of current and predicted future pressures on cold-water biodiversity;
- Conduct research to assess how climate change and other human-induced stressors will impact the physiology, health and long-term viability of cold-water organisms, habitats and ecosystems;
- Improve monitoring of environmental conditions in cold-water habitats to understand variability in carbonate chemistry;
- Develop or expand upon predictive model research to determine how projected climate change will impact cold-water biodiversity over different time scales.

5.5 SDG 14.5 /Aichi Target 11 – 10% Target, consideration of OECMs

United Nations **Sustainable Development Goal (SDG) 14** seeks to "conserve and sustainably use the oceans, seas and marine resources for sustainable development" by achieving a 10% protected area spatial target by 2030, with sub-targets that place further emphasis on the economic and social context of conservation measures to aid global development[169].

The Convention on Biological Diversity (CBD) **Aichi Biodiversity Target 11** states that, "by 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes"[170].

Rees *et al*. (in press) suggest the principles of "sustainability" and "economic benefits" embedded in SDG 14 can be strengthened by the qualitative aspects of Aichi Target 11. The authors suggest that 'through the identification of "areas important for biodiversity and ecosystem services" human wellbeing is supported by the incorporation of areas that provide broadscale ecological functions (*e.g.* productivity) and areas where ecosystem services are realised (*e.g.* food provision). Through the incorporation of the principles that have been developed under Aichi Target 11 to build resistance and resilience into protected areas networks by being "well-connected", "ecologically representative" and "integrated into the seascapes" the risks associated with cumulative stressors on the marine environment that may impact upon sustainability are reduced. By including metrics to evaluate whether a protected area is "effective and equitably managed" it is possible to identify learning and good practice to support improved sustainability in marine management. Through the integration of "protected areas into wider landscapes and seascapes" the wider sectoral interests (along with their legal frameworks) can be taken into account to plan for a seascape supports both biodiversity conservation and sustainable development'.

Diz *et al*.[171] (in review) also emphasise the utility of VMEs in the context of 'Other Effective Conservation Measures' to meet these MPA targets.

5.6 World Ocean Assessment

The First Global Integrated Marine Assessment – World Ocean Assessment I - carried out under the auspices of the United Nations, and published in 2016[172], concluded, *i.a.*, that:

- Climate change and related atmospheric changes seriously impact the ocean, with increasing trends of sea level rise and acidification, and decreased mixing and oxygenation;
- There are increasing pressures on marine biodiversity, including in the open ocean;
- Increasing use of ocean space, from the expansion of existing activities and from the development of new ones, increase "the potential for conflicting and cumulative pressures" particularly as "in most cases, those various activities are increasing without any clear overarching management system or a thorough evaluation of their cumulative impacts on the ocean environment"[173];
- Sustainable ocean use cannot be achieved without coherent and overall management of the various activities affecting the ocean, based on vaster and more integrated knowledge on the ocean; and

- Delays in implementing known measures to counteract the identified pressures mean that "we are unnecessarily incurring those environmental, social and economic costs"[174].

Specifically for the North Atlantic, and despite existing data deficiencies, the report refers to climate change as a "major and growing pressure"[175]. It highlights how "efforts towards sustainability have been greatly aided by coordinated international efforts to provide scientific and technical information on the status and trends in biodiversity, and threats to sustainable uses", *i.a.*, through CBD's EBSAs and FAO's VMEs[176]. Although "many biodiversity impacts, particularly at larger scales, are the result of cumulative and interactive effects of multiple pressures from multiple drivers", it "has repeatedly proven difficult to disentangle the effects of the individual pressures, impeding the ability to address the individual causes"[177]. The authors conclude that "the North Atlantic presents examples of both the extent to which unsustainable actions can adversely affect biodiversity and the benefits that can accrue from policies and programmes that are well developed, adequately resourced, and effectively implemented" but recall that "All of these improvements have come with at least short-term costs, which are sometimes large" (*e.g.* displaced or reduced fishing opportunity, costs of pollution control, or the direct costs of habitat restoration, which may amount to spendings in the millions even for moderate scale restoration projects)[178].

5.7 BBNJ

Currently a key global process addressing area-based management tools in ABNJ is the Preparatory Committee established by UNGA resolution 69/292: development of an international legally binding instrument under the UNCLOS on the conservation and sustainable use of marine biological diversity of ABNJ (BBNJ) (cf. Section 1.4.2. of this report). After an 11-year period of informal discussions, Parties have recognised the need to secure the importance of marine biodiversity for ocean health, productivity, resilience, food security and ecosystem services as a legal gap. Provision was made for four meetings of the Preparatory Committee leading to an intergovernmental conference to establish a biodiversity Implementing Agreement (IA). Ahead of PrepCom3 (April 2017) Parties were invited to submit views on elements of 'the package', one of which is ABMT including MPAs. The views of littoral States to the North Atlantic are summarised in Table 5.1.

Table 5.1. – Views of littoral States to the N Atlantic on ABMT.

State or Group	Summary of views on ABMT submitted to BBNJ Chair (5 December 2016)
Canada	Considers objectives can largely be achieved within existing governance regimes, but encouragement is needed to carry is needed for regional and sectoral authorities to carry out their mandated activities. Adhere to ecosystem based management, precautionary approach, best available science. Enable cooperation and collaboration, facilitate consultation and adaptive management.
United States	The IA should agree scientific criteria, objectives, activities, a mechanism for considering new areas, their designation and potential management measures and a notification procedure consistent with UNCLOS and obligations.
Iceland	Respect mandate and prerogatives of institutions and existing legal instruments. Highlighted NE Atlantic Collective Arrangement. See 1995 UN Fish Stocks Agreement as a comprehensive legal framework for high seas fisheries. Support a wide definition of ABMTs that encompasses protected areas created by RFMOs.
Norway	Acknowledge important tools already in use by different management mechanisms. Emphasise complementarity, closer coordination and cooperation between regional and sectoral mechanisms. Support general requirements including best available science, spurring States engagement, providing for accountability, transparency, review and stakeholder participation. Would like to see new Regional Seas Conventions where gaps in coverage exist.
EU	Essential tools, especially MPAs, for enhancing resilience to climate change, recognise 'vulnerability' of features to drive levels of protection and the creation of an ecologically coherent global network of representative and effectively managed MPAs. Suggested definition as 'a spatial management tool for a geographically defined area through which one or several sectors/activities are managed with the aim of achieving particular objectives and affording higher protection than the surrounding areas'. Detailed comments on identification, proposals, consultation process, scientific assessment, decision-making, implementation, reporting and review (envisaging a regular review mechanism). Recognition of existing designations.

Working towards a new legally binding instrument has had to consider the merits of vertical, horizontal, top-down and bottom-up approaches to ABMTs, as well as different mechanisms of States acting individually or collectively. Deliberations on ABMT at the 3rd meeting of the Preparatory Committee (27 March to 7 April, 2017) accepted that ABMTs can contribute to the maintenance and restoration of ocean ecosystem health. Different categories of ABMTs are acknowledged including reserves and areas promoting sustainable uses (*i.e.* IUCN categories for MPAs). Most Parties would like any competent multilateral body to achieve ecosystem resilience building in ABNJ but a number of models were envisaged as to how this should be instituted: a global institution, regional coordination mechanisms with global guidance, or a regional/sectoral model promoting cooperation without global oversight. Open questions also include how to enhance cooperation without undermining existing arrangements; how to provide best available science advice; achieving stakeholder consultations; and any role for adjacent States. Some interventions were not in favour of percentage targets but to date the emphasis has been on process. There has been little or no discussion of accounting for threats and risks to those areas selected although PrepCom3 did raise the need to factor in climate change concerns into specific elements of the new treaty.

5.8 European Marine Board research agenda

The European Marine Board (EMB) (www.marineboard.eu) is a pan-European platform to develop common priorities, advance marine research and bridge the science-policy gap. In their 2015 policy brief entitled "Delving Deeper", on achieving sustainable management of the deep sea through integrated research, the EMB proposed the following set of recommendations and key action areas[179]:

- Increase fundamental knowledge of the deep sea, as a fundamental enabler for all economic activities in the seas and oceans;
- Assessing drivers, pressures and impacts in the deep sea, particularly in ABNJ;
- Promoting cross-disciplinary research and cross-sector research collaboration to address complex deep-sea challenges;
- Innovative funding mechanisms (including public-private partnerships)
- Advanced technology and infrastructure for deep-sea research and observation;
- Fostering capacities in deep-sea research including in the training of early career researchers;
- Promoting transparency and open data access and appropriate governance of deep-sea resources;
- Promote deep-ocean literacy to inspire and educate society to value deep-sea ecosystems, goods and services

Although this policy brief mentions that the deep ocean is affected by the effects of climate change, no specific proposals concerning adaptation to climate change are presented.

5.9 Atlantic Ocean Research Alliance (AORA)

In the framework of the Galway Statement on Atlantic Ocean Cooperation (cf. Section 1.2.3. of this Report), AORA's Working Group (WG) on the Ecosystem Approach to Ocean Health and Stressors met in Reykjavik, Iceland 23-27 January 2017, to explore challenges and research and science needs and opportunities.

Among the main challenges identified are the lack of a shared language and a common understanding of concepts across sectors and disciplines, which affects cooperation. Further scientific challenges include a need for greater collaboration with the social sciences, and a robust assessment of the effect of scale across sectors, uses, stressors, goods, services, and ecosystem components. Understanding risks associated with maritime activities and capturing cumulative effects, including relating to climate change, are also outstanding challenges[180].

To address these challenges, AORA's Working Group proposed a roadmap as a means to make progress on the science to support EBM, whose steps cover[181]: 1) development of common language/vocabulary as a basis for collaboration; 2) stakeholder engagement; 3) review of governance mandates; 4) linking sectors and ecosystems effects; 5) identifying gaps in knowledge and uptake of science; 6) identification of tools for EBM; 7) communication; and 8) research priorities.

5.10 International Council for the Exploration of the Sea (ICES)

ICES is a global network of 5,000+ scientists from 20 member countries[182] established in 1902 as an intergovernmental organization (http://www.ices.dk). ICES stated mission is, through strategic partnerships, "to advance the scientific understanding of marine ecosystems, and provide information, knowledge, and advice on the sustainable management of human activities affecting, and affected by, marine ecosystems."[183]

5.11 Chapter synthesis

Each of these elements should be taken into account when considering priorities for expert assessment. They represent independent but inter-related ongoing processes contributing to a complex and incomplete governance matrix.

To date only the OSPAR MPAs have considered whether or not there is any biological connectivity between the different designations. The CBD EBSA process has yet to address Annex II of Decision X/29 and VMEs are designated based on the presence of indicator species irrespective of whether or how communities relate to one another.

The contribution of the ATLAS project is to update scientific understanding and test aspects of the different expert processes in support of new/expanded Blue Growth activities. Key considerations will be:

- Level of scientific data available to support implementation of MSP;
- Evaluating how any new/expanded activity is likely to affect existing activities (including conservation initiatives) and contribute to cumulative impacts;
- In support of blue growth to streamline the EIA process through collaboration and data sharing with industry.

It is noteworthy that the ATLAS project is working on all of the actions set out in CBD COP 13 Decision XIII/11 related to biodiversity in cold-water areas referred to in section 5.4. (above).

6 Integrating Climate Change (or Climate-proofing ABMTs)

6.1 Introduction

The different area-based management tools (MPAs, EBSAs, and VMEs) in the North Atlantic ABNJ identified/designated in response to various international policy drivers, comprise areas of 'critical natural capital', the protection of which should be prioritized in the context of actual and/or potential human impacts. Key pressures from human impacts are regulated comprehensively in the North Atlantic by the respective RFMOs (fisheries) – see section 4.3 – and the International Maritime Organization (international shipping). Other human uses have a limited footprint in the deep-sea[184]. In the future new uses may become an issue. Oil and gas exploration blocks have already been authorised (namely in the NAFO area[185]) and future deepsea mining exploration may impact the North Atlantic[186].

The oceans are a major sink for CO_2 produced by human activities and for the heat resulting from the associated greenhouse effect[187]. As a consequence perhaps the greatest threat to deep-sea ecosystems is from ongoing climate change[188] and it is critically important to understand if and when (in the near future 30-50 years) these areas (and their constituent ecological features) may be also be vulnerable to adverse impacts of climate change and geochemical changes (ocean acidification). We have chosen the 30-50 year time frame as it is hoped that areas closed to address current international policy directives will have decadal scale longevity, although the IPCC climate models have been developed for maximum precision at 2100.

Shifts in environmental gradients will likely affect habitat suitability and representativeness, redistribute species[189] and change ecological assemblage composition and interactions (often via recruitment regimes) (cf. Box 6.1. for terminology relating to climate change pertinent to this report). However, despite projected spatial and temporal variation resulting from climate change impacts, MPA networks are still being designed on the basis of contemporary environmental and habitat conditions[190]. Furthermore, as shown in chapter 5 of this report, the existing initiatives for the evaluation of ABMTs in ABNJ in the North Atlantic constitute independent (albeit inter-related) ongoing processes contributing to a complex and incomplete governance matrix where climate change considerations are not prioritised.

This chapter seeks to evaluate EBSAs, VME closures and MPAs in the North Atlantic for risk from climate change. In doing so we identify knowledge gaps and spatial and temporal scale issues in climate models which impede implementation of CBD's COP13 Decision XIII/11.

Box 6.1. – Some climate-related definitions

Climate change[191] Climate change refers to a change in the state of the climate that can be identified (*e.g.*, by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the UN's Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes. See also Detection and Attribution. {WGI, II, III}

Adaptation[192] The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects1. {WGII, III}

Mitigation (of climate change)[193] A human intervention to reduce the sources or enhance the sinks of greenhouse gases (GHGs). This report also assesses human interventions to reduce the sources of other substances which may contribute directly or indirectly to limiting climate change, including, for example, the reduction of particulate matter emissions that can directly alter the radiation balance (*e.g.*, black carbon) or measures that control emissions of carbon monoxide, nitrogen oxides, Volatile Organic Compounds and other pollutants that can alter the concentration of tropospheric ozone which has an indirect effect on the climate. {WGI, II, III}

Resilience The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation[194]. Holling (1973) defined resilience simply as: "the magnitude of the disturbance that a system can absorb without fundamentally changing."[195]

6.2 Methodology

To achieve these objectives, and drawing from the work of the Study Group on Designing MPA Networks in a Changing Climate[196,197] (SGMPAN, joining up ICES and the Commission for Environmental Cooperation (CEC), through its North American Marine Protected Areas Network (NAMPAN) Technical Group), the following step by step methodology was designed/adopted (schematised in Figure 6.1.):

1. Review of projected changes in the ocean in the near term and longer term, at the global and regional North Atlantic level (also informed by the ATLAS project), in terms of five main oceanographic variables: temperature, pH, dissolved oxygen, POC flux, circulation (specifically the AMOC). The list of key stressors used in this analysis was determined by the relevant literature (e.g., Levin and LeBris, 2015; Sweetman et al., 2017)[198,199]. Both of these studies focused on their analysis on four key aspects: temperature (warming), pH (acidification), dissolved oxygen (deoxygenation), and changes in seafloor particulate organic carbon (POC) fluxes. A fifth one, the AMOC, was included in this study, due to its relevance in the North Atlantic, and also because it is specifically being studied in the framework of the ATLAS project. The five chosen are sufficiently well studied at the Atlantic wide scale and have sufficient information on their impact on the ecosystem components of relevance to predict climate change effects. They relate to potential large-scale or climate stressors (linked to IPCC chapters and other "climate" summaries): Green House Emission; Global Warming; Arctic and Greenland Melt; Ventilation and AMOC; Ocean Acidification; Hypoxia and Hydrological Cycle Acceleration.
2. General expected effects of the oceanographic changes described in step 1 on major ecosystem components of the Atlantic (incl. plankton, fish, benthos, marine mammals, birds, and turtles).
3. Review of main taxa described for OSPAR MPAs (Chapter 2), CBD EBSAs (Chapter 3), FAO VMEs (Chapter 4) and how they are expected to be affected by these five changing oceanographic variables (information from step 2);
4. Review of existence or absence of main traits expected to confer resilience to climate change impacts in each of the ABMTs considered in this study (OSPAR MPAs, EBSAs, VMEs) and provide a highly subjective resilience ranking (High, Medium, Low) for all ABMT based on their rationale for implementation and the supporting literature. This was done by summing the number of traits that are thought to confer high resilience

(N=10) and down grading by one category if traits thought to confer low resilience (N=7) were present. High resilience was assigned for 6 or more traits, and at all levels; Medium for 4 or 5 traits and at all levels; Low for fewer than 4 traits and/or no information at one or more levels in the first instance (prior to downgrading). In this way areas with insufficient knowledge would result in lower overall rankings due to the influence of the presence of high resilience traits.

5. Solicit expert opinion on the draft findings from the previous steps from a focus group at ATLAS 2nd General Assembly.
6. Based on the results of the previous steps, draw up a list of recommendations.

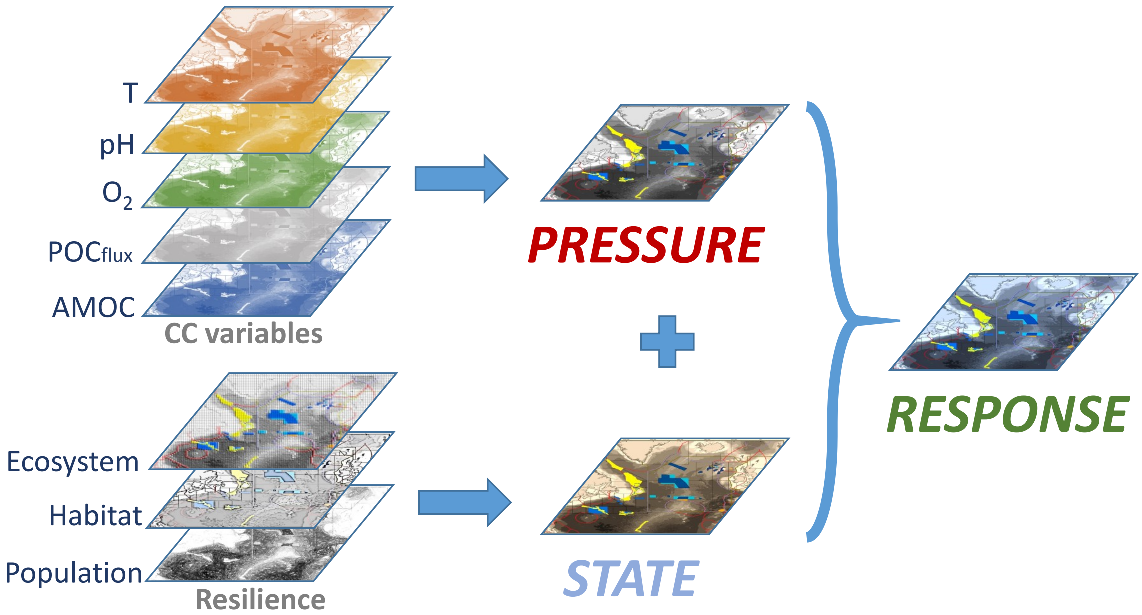

Figure 6.1. Methodology schematic.

6.3 Projected changes in the ocean

This section draws on information from the IPCC 5th Assessment Report (2013, 2014) [200,201]. This section also draws from work published by OSPAR (2009)[202] on the expected results of CC in the NE Atlantic and ICES (2011) on the NW Atlantic[203] and on additional key references[204,205,206,207].

6.3.1 Global trends

In the near-term (2035-2050), changes in sea surface salinity (SSS) are expected in response to changes in precipitation, evaporation and runoff, as well as ocean circulation and ice melt; in general, salty regions are expected to become saltier and fresh regions fresher (Figure 6.2.). Available climate model projections suggest that high SSS subtropical regions that are dominated by net evaporation are typically getting more saline; lower SSS regions at high latitudes are typically getting fresher. Projections suggest a continuation of this trend in the Atlantic where subtropical surface waters become more saline as the century progresses (Figure 6.3.)

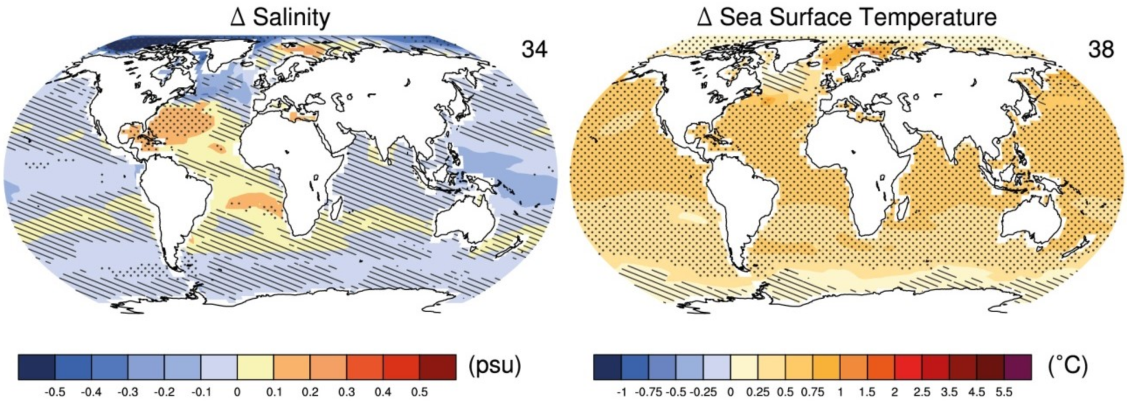

Figure 6.2. Projected changes in sea surface salinity (left panel; practical salinity units) and sea surface temperature (right panel; °C) for 2016–2035 relative to 1986–2005 under RCP4.5. Hatching indicates areas where projected changes are small compared to internal variability; stippling indicates regions where projections deviate significantly from the simulated 1986–2005 period. The number in the top-right portion of the panels indicates the number of models considered in the analysis.

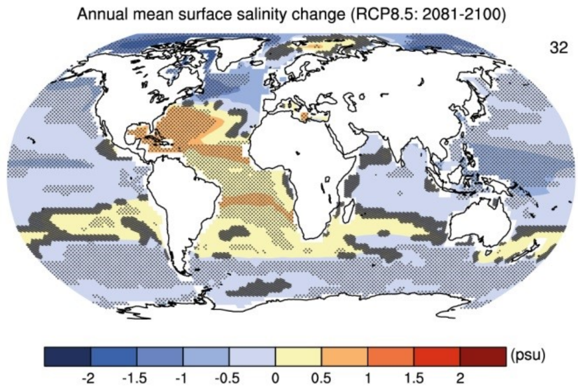

Figure 6.3. Projected sea surface salinity differences in 2081–2100 relative to 1986–2005. Hatching indicates regions where the multi-model mean change is inferior to the internal variability; Stippling indicates regions where the multi-model mean change is greater than twice the internal variability and where at least 90% of the models agree on the sign of change. The number of models used is indicated in the upper right corner.

Globally averaged surface and near-surface ocean temperatures are projected to warm over the early 21st century, being *very likely* (90-100% probability) that globally averaged sea surface temperature (SST) and depth-averaged temperatures between 2016–2035 will be warmer than between 1986–2005. Regional variations in projected ocean temperature changes are influenced by ocean circulation and by surface heating (Figure 6.2). Inter-decadal variability of upper ocean temperatures is larger in mid-latitudes, particularly in the northern hemisphere, than in the tropics, meaning that the anthropogenic warming signal will take longer to emerge from the noise of internal variability in the mid-latitudes than in the tropics.

In the longer term (until the end of the 21st century) the global ocean will warm in all scenarios, with the strongest warming being projected for the surface in subtropical and tropical regions. While the projected increase of SST and heat content over the next two decades is relatively insensitive to the emissions trajectory, as SST continues to increase, heat is expected to propagate to greater depths due to large-scale general circulation and by smaller-scale mixing processes.

Figure 6.4. shows the multi-model mean projections of zonally averaged ocean temperature change under three emission scenarios. Surface warming varies considerably between the emission scenarios ranging from about 1°C (left panel) to more than 3°C (right panel). The strongest warming occurs in the top few hundred metres of the subtropical gyres. Mixing and advection gradually transfer the additional heat to > 2000 m by 2100 (Box 6.2.).

Box 6.2. Key message from IPCC reports

Depending on the emission scenario, global ocean warming between 0.5°C-1.5°C will reach 1 km deep by 2100. By 2100, 50% of the energy taken up by the ocean will be in the upper 700 m, and 85% in the upper 2000 m (intermediate scenario). A slight cooling is anticipated in parts of the northern mid- and high latitudes below 1000 m, which may be linked to the projected decrease of the strength of the Atlantic Meridional Overturning Circulation (AMOC) (cf. Box 6.2. below).

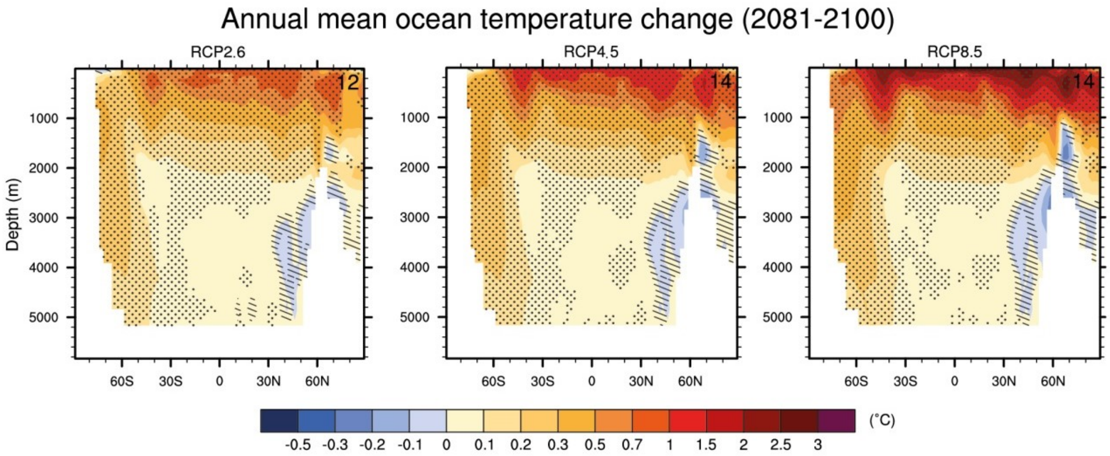

Figure 6.4. Annual mean zonal mean temperature in the ocean relative to 1986–2005 for 2081–2100 under different forcing scenarios. Hatching: regions where the multi-model mean change is less than one standard deviation of internal variability. Stippling: regions where the multi-model change mean is greater than two standard deviations of internal variability and where at least 90% of the models agree on the sign of change.

The response of ocean temperatures to external forcing comprises mainly two time scales: a relatively fast adjustment of the ocean mixed layer and the slow response of the deep ocean (simulations suggest timescales of several millennia until the deep ocean is in equilibrium with the external forcing). Thus, the long timescale of the ocean response to external forcing implies an additional commitment to warming for many centuries when greenhouse gas (GHG) emissions are decreased or concentrations kept constant.

6.3.2 Projected regional climate change in the North Atlantic

The ocean climate of the North Atlantic varies strongly with latitude and season, being influenced by atmospheric forcing, continental run-off, Arctic outflows and tropical inflows, the North Atlantic's major gyral circulations, and the complex geometry of the coastline and continental margin. The region's climate is also strongly influenced by several large-scale natural atmospheric and/or ocean circulation phenomena, including the North Atlantic Oscillation (NAO), the Tropical Atlantic Variability (TAV), the Atlantic Multidecadal Oscillation (AMO), and the Atlantic Meridional Overturning Circulation (AMOC), with natural seasonal to decadal cycles (Table 6.1). The AMOC (Cf. Box 6.3.), for instance, is known to play an important role in the decadal variability of the North Atlantic Ocean, but its natural variability over these timescales is poorly known and poorly understood.

Table 6.1. Major large-scale oceanographic regions in or affecting the western North Atlantic (within the ATLAS area): predominant features, primary modes of climate/weather variability, coastal/shelf oceanographic subregions, and additional key distinguishing features. From Brock *et al*., 2012.[208]

Major oceanographic regions	Predominant oceanographic features	Modes of climate variability	Marine ecoregions	Coastal/shelf oceanographic subregions	Additional key subregional features
SubPolar NW Atlantic (SP-NWA)	Labrador Current (southward flow); Seasonal sea ice; Wintertime deep convection; Seasonally varying stratification	NAO direct, AO remote, AMOC, AMO	Baffin / Labradoran Arctic	Baffin bay	Cyclonic gyre; Melting glaciers
				Labrador Shelf, Slope & Sea	Run-off; Hudson Strait outflow
				NE Newfoundland Shelf & Slope	2-3 layer stratification
Western North Atlantic (WNA) Mid-Latitude Transition Zone (ML-TZ)	Labrador Current Extension (equatorward shelf flow); Slope Water; Gulf Stream (offshore); Strong seasonality (continental lee);	NAO via advection, AMO, AMOC	Acadian Atlantic (shelf); Northern Gulf Stream (NGS) Transition (slope)	Grand Banks & Flemish Cap	Clockwise gyres; 2-3 layer stratification
				Gulf St Lawrence (GSL)	Run-off; Seasonal sea ice
				Scotian Shelf	GSL outflow; Banks & basins
				Gulf of Maine & Bay of Fundy	Tidal influences; Run-off; Banks & basins
			Virginian Atlantic (shelf); NGS Transition	Mid Atlantic Bight	Run-off; Barrier beaches; Coastal fronts & flows

Box 6.3. Atlantic Meridional Overturning Circulation (AMOC) (in Delworth *et al*., 2008)[209]

"The AMOC is an important component of the Earth's climate system. It is characterized by a northward flow of warm, salty water in the upper layers of the Atlantic, and a southward flow of colder water in the deep Atlantic. This ocean circulation system transports a substantial amount of heat from the Tropics and Southern Hemisphere toward the North Atlantic, where the heat is transferred to the atmosphere. Changes in this circulation have a profound impact on the global climate system (...)"

Anthropogenically-influenced changes in many ocean variables, such as salinity, temperature, acidity (pH), POC (particulate organic carbon) fluxes, are already occurring and expected to become of increasing importance and predominance over natural variability, as the century proceeds. Current trends in increasing ocean temperature, and acidity, are expected to continue to rise, despite projected important regional variations in magnitude (cf. Table 6.2.). Currents and stratification, strongly influenced by local run-off and winds, may also vary regionally and seasonally, complicating the task of projecting their relevant changes to particular ecosystem issues.

Table 6.2. Four major environmental variables at the deep seabed likely to be altered before 2100 by increased atmospheric emissions of CO_2. From Sweetman *et al*., 2017[210].

Depth	Temp. (°C)	Dissolved oxygen (mL/L)	pH	Seafloor POC flux (mg C m^{-2} d^{-1})
		Presently, much of the Atlantic Ocean is well oxygenated	The N Atlantic has the most alkaline bottom pH. Model predictions estimate that in the N Atlantic > 17% of the seafloor < 500 m will undergo pH reductions > 0.2 units notably over seamounts and canyons	Most of the deep sea, particularly the abyss, characterized by severe food limitation (POC flux of 1-2 g C m^{-2} yr^{-1})
Bathyal (200-3,000m)	Present: -1.23 to 27.83 2100: -0.32 to 4.41	Present: 1.48 to 7.54 2100: -0.03 to 0.02 Rel. Change (%): -0.68 to 2.05	Present: 7.71 to 8.25 2100: -0.37 to -0.01	Present: 1.4 to 108.05 2100: -13.73 to 0.63 Rel. Change (%): -36.27 to 4.79
Abyssal (3,000-6,000 m)	Present: -0.07 to 4.39 2100: -0.37 to 0.98	Present: 4.6 to 6.92 2100: -0.03 to 0 Rel. Change (%): -0.44 to -0.02	Present: 7.98 to 8.11 2100: -0.13 to 0	Present: 0.69 to 10.41 2100: -1.27 to -0.02 Rel. Change (%): -27.12 to -1.26

It is *likely* (66-100% probability) that there will be increases in salinity in the tropical and (especially) subtropical Atlantic over the next few decades (Figure 6.2). Projected near-term increases in freshwater flux into the North Atlantic (from melting Arctic ice) contribute to decreased density of the ocean surface layer and could reduce deep ocean convection. Overall the North Atlantic exhibits a trend of increasing sea surface salinity since 1995, however, deep waters of the North Atlantic have freshened in the last 40-50 years.

Almost all climate model projections reveal an increase of high latitude temperature and precipitation, which will contribute to make the surface waters lighter and hence more stable.

The North Atlantic's major western boundary currents, the Labrador Current and Gulf Stream, provide a high level of spatial (latitudinal) connectivity within the sub-polar and subtropical waters, respectively. In addition, the transports of cold fresh water southward by the Labrador Current, and of warm saline water northward by the Gulf Stream, result in a pronounced mid-latitude ocean climate "transition zone" between the Grand Bank and Cape Hatteras. Enhanced climate changes in some variables (*e.g.*, salinity) are expected in this zone, associated with a probable northward shift of the Gulf Stream's position. AMOC is *likely* to decline by 2050 (medium confidence). It is very likely that AMOC will weaken throughout the 21st century but very unlikely that it will undergo an abrupt transition or collapse in that time scale. However, the rate and magnitude of weakening is *very uncertain* and, due to large internal variability, there may be decades when increases occur[211]. There is low confidence in projections of when an anthropogenic influence on the AMOC might be detected. For steady weakening of the AMOC throughout the 21st Century detection by observations will take around 30-years[212]. Careful analysis of the climate model projections suggests that climate model biases[213] result in artificially stable projections for the AMOC. There is a higher probability of abrupt collapse than previously understood[214] due to unrealistic representation of stratification in the subpolar gyre and deep Labrador Sea convection. As a consequence the CMIP5 ensemble underestimates the chance of abrupt cooling, and this has implications for observation and policy. Emerging work under ATLAS[215] shows evidence for a weakening of Labrador Sea convection during the industrial era. This has implications for connectivity in the deep sea. ATLAS work on connectivity among *Lophelia pertusa* reefs in the NE Atlantic has shown that connectivity patterns can be significantly different under different oceanographic regimes[216]. A climatic shift of mean atmospheric conditions, towards either a more positive or more negative state of the North Atlantic Oscillation could have a profound effect on the connectivity and ecosystem function of population networks in the NE Atlantic. This dynamic nature imposed by currents needs further trans-Atlantic assessments for other key ecosystem components.

Table 6.3. summarises tendencies for anthropogenic climate change in key upper-ocean (100-1000 m depth) physical oceanographic properties affecting ecosystems in the W North Atlantic. Substantial uncertainty concerning the magnitude of future ocean climate change on the space and time scales of importance to many marine ecosystems subsists. However, "climate changes can be expected to penetrate to intermediate (1000–2500m) and greater depths on the time scales of years to decades over much of the Western North Atlantic's continental margin, associated with the AMOC"[217]

Table 6.3. Tendencies for anthropogenic climate change in key upper-ocean (100-1000m depth) physical oceanographic properties affecting ecosystems in the W North Atlantic (WNA). The time horizon on which these changes might be expected to become more important than natural decadal-scale variability varies with the variable, but all might be expected to do so within a few decades. The large-scale tendencies for particular features of these variables are noted, and the relative magnitude of the tendencies among the major oceanographic regions for each feature are indicated using multiple + (increase) and – (decrease) signs ("?" indicates uncertainty in the sign of the tendency). Different uncertainties in the tendencies associated present knowledge gaps are indicated by the following color code rating for probable occurrence: Highly probable, probable. From Brock *et al*., 2012.[218]

Ocean variable	Feature	Large scale tendencies for WNA	SP-NWA	ML-TZ
Large-scale ocean circulation	AMOC	Slowed AMOC	-	-
	SP & ST gyres	Retracted SP Gyre	-	
	IAS inflow	Expanded ST gyre & N-shifted Gulf Stream		++
	Loop current	Reduced mean & eddy flow in IAS		
Coastal & Shelf Circulation	Buoyancy- & wind-driven currents; Fronts	Enhanced buoyancy flows & fronts	+++	++
Sea ice extent and volume	Winter & spring only	Reduced where present	--	---
Upper-Ocean stratification	Surface mixed layers	Widespread increased stratification, thinner mixed layers & reduced vertical mixing	+++	++
Temperature	Near-surface	Widespread surface-intensified warming; reduced magnitude in north	+	++++
	Winter modified layer		+	++
	Shelf/slope bottom	Subtropical water expansion in ML-TZ	+	+++
Salinity	Offshore (in upper few 100m)	Decrease in SP-NWA Increase in ML-TZ, ST-WNA & GM	---	+++
		Modified currents depending on local winds	?	?
Dissolved Oxygen	Subsurface minima	Widespread reduced concentration in layer bellow new shallower depth of wintertime ventilation	--	-
Ocean Acidity	Upper-ocean	Widespread increase in winter ventilated areas; more severe in colder waters	+++	+
Nutrients	Vertical supply to euphotic zone	Widespread reduction	-	-
		Subregional differences in coastal and shelf areas	?	?
	Altered levels due to circulation changes	Increases and decreases in different nutrients associated with changing Artic outflows	+/-	+/-
		Decrease in ML-TZ due to increased subtropical influence		-

6.4 Projected climate change impacts on ecosystem components

Different ecosystem components, such as plankton, a plethora of benthic organisms, fish, sea mammals, birds, and turtles, will react/respond differently to individual environmental gradient stressors, and to the combined (cumulative) effects of a rapidly changing environment under climate change. The likelihood of effects of oceanographic changes on generic ecosystem components based on trends of changing atmospheric and oceanographic physical conditions in the Atlantic are presented in Table 6.4. and graphically synthesised in Figure 6.5. Amongst the benthic invertebrates, xenophyophores, cold water corals and certain deep sea sponge aggregations were noted in the FAO 2009 Deep Sea Fisheries Guidelines[219] and are considered herein.

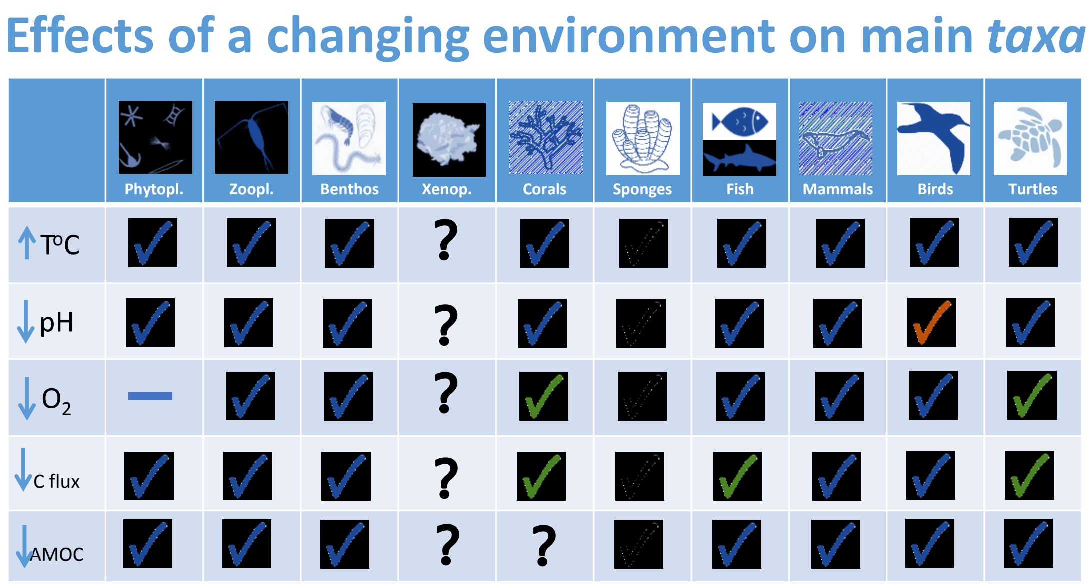

Figure 6.5. Likelihood of effects of changing oceanographic parameters on main marine taxa (from FAO, 2009[220]). Blue: extremely likely; Green: more than likely; Red: likely. –: no effect; tick marks: expected effect; ?: unknown. Xenop.: Xenophyophores

Tables VI.1. to VI.4 (Annex VI) summarize the expected effects of climate change, discriminated by depth, pH/acidification, reduction in O_2 (hypoxia), increasing ocean water temperature, reduced flux of particulate organic carbon (POC) to the bottom, and reduction in the AMOC, as well as the expected time frame of first impacts, respectively on the main ecological components of OSPAR high seas MPAs (Table VI.1.), North Atlantic EBSAs (Table VI.2.), NAFO VME closures (Table VI.3.) and NEAFC VME closures (Table VI.4.). This information is synthesised in figures 6.4. to 6.7.

Table 6.4. Generalized effects of climate-driven oceanographic changes on components of the ecosystem. Colors indicate the likelihood of the response: blue indicates "extremely likely," green indicates "more than likely," red indicates likely, and unknown effects are indicated with "?". The expected effects are described at the scale of ecoregion or broader, recognizing that effects will vary at smaller spatial scales and that some effects will not directly affect some ecoregions (*i.e.*, ice melt will not directly affect tropical species, but may indirectly affect them via changes in global circulation). "Changes in vital rates" refers to changes in growth, reproductive success, and/or mortality that ultimately change population abundance and the relative increase/decrease in vital rates is not specified as the direction and magnitude of the change in vital rates is species-specific. (aspects not included: Intensification of hydrological cycle; increase in sea level); From Brock *et al*., 2012[221].

Pressure	Phytoplankton	Zooplankton	Benthos	Corals	Fish	Marine mammals	Turtles	Marine birds
Increase in Temperature	Smaller average size; Dominance of smaller species; Changes in vital rates	Increases in jellyfish abundance; Increases in metabolism, growth and development; Trophic effects lead to reduced condition	Northward shift in distribution; Shifts to deeper depths; Change in vital rates; Mass mortality events in sessile spp.; Increased disease	Bleaching and decrease in calcification leading to mortality in many cases; Changes in vital rates; Shifts in distribution	Northward shift in distribution or shift to deeper depths; Change in vital rates	Change in vital rates dependent on prey response; Thermoregulation issues	Changes in distribution, timing of migration and reproduction; Change in hatching sex ratios; Change in vital rates dependent on prey response	Change in migratory timing and routes; Changes in distribution; Indirect effects of invasive species; Thermoregulatory stress
Changes in stratification	Prim. Production increases in N and decreases in S and shelf regions; Earlier, more intense spring blooms at temp. latitudes, change in spp. composition	Follows changes in primary production	Change in flux of organic material to benthos, leading to changes in productivity	Changes in light availability and vertical migration; Shifts in distribution	Change in vertical position of pelagic eggs and larvae; Change in trophic interactions	Change in sound propagation affecting communication and predator avoidance; Reduced feeding opportunities	Changes in vital rates dependent on prey availability	Changes in vital rates dependent on prey availability ?
Changes in ocean circulation patterns	Northward shift of warm-water species; Introduction of Pacific species from Arctic	Northward shift of warm-water species; Introduction of Pacific spp. from Arctic; Increase in diversity in northern latitudes	Northward shift in warm-water species; Change in larval dispersal and population connectivity	Change in larval dispersal and in reef connectivity leading to shifts in distribution; Change in food availability	Northward shift in warm-water spp; Change in larval dispersal and population connectivity	Altered migratory and residency patterns; Altered prey availability will affect vital rates	Changes in vital rates dependent on prey availability; Changes in migratory routes	Changes in vital rates dependent on prey availability
Ocean acidification	Reduced production of calcifying phytoplankton and possible extinction	Red. production of calcifying organisms if unable to form skeleton and possible extinction	Lower growth and decrease in shell strength of benthic calcifiers	Decreases in calcification rates; Change in reproduction; Decrease in food availability	Little change in growth or mortality, but reduced ability to settle on coral reefs and avoid predators	Better sound propagation, changes in prey availability and abundance	Change in vital rates dependent on prey availability	Change in vital rates dependent on prey response
Increase in oxygen minimum zones/ Hypoxia	No effect	Species distributions may change; Jellyfish become more prevalent	Increase in mortality due to coastal hypoxia; Change in species composition and distribution	Habitat reduction and mortality in cold water corals	Habitat decrease, reduced growth and thermal tolerance; Change in vital rates dependent on prey	Change in vital rates dependent on prey availability	Change in vital rates dependent on prey availability	Change in vital rates dependent on prey availability

Pressure	Phytoplankton	Zooplankton	Benthos	Corals	Fish	Marine mammals	Turtles	Marine birds
					availability			
Reductions in sea ice cover	Change in spp. assemblage, earlier pelagic blooms; Higher prim. production	Change in spp. assemblage; Increased production	Change in spp. composition; Predatory release	Food delivery changes for shallow cold water corals, algal overgrowth	Southward shift of Arctic spp.; Increase in available coastal habitat in North	Reduced polar bear and seal habitat including seal breeding habitat	No effect	Earlier arrival of birds at breeding grounds; Changes in distribution
Reduced AMOC (Northward shift of Gulf Stream)	Introduction of warm water spp. to northern ecosystems	Introduction of warm water spp. to northern ecosystems	Introduction of warm water spp. to northern ecosystems	?	Change in migration, introduction of warm water spp. to northern ecosystems	Change in vital rates dependent on prey availability	Affects distribution and migration as well as prey availability	Shift in distribution and change in vital rates dependent on prey availability

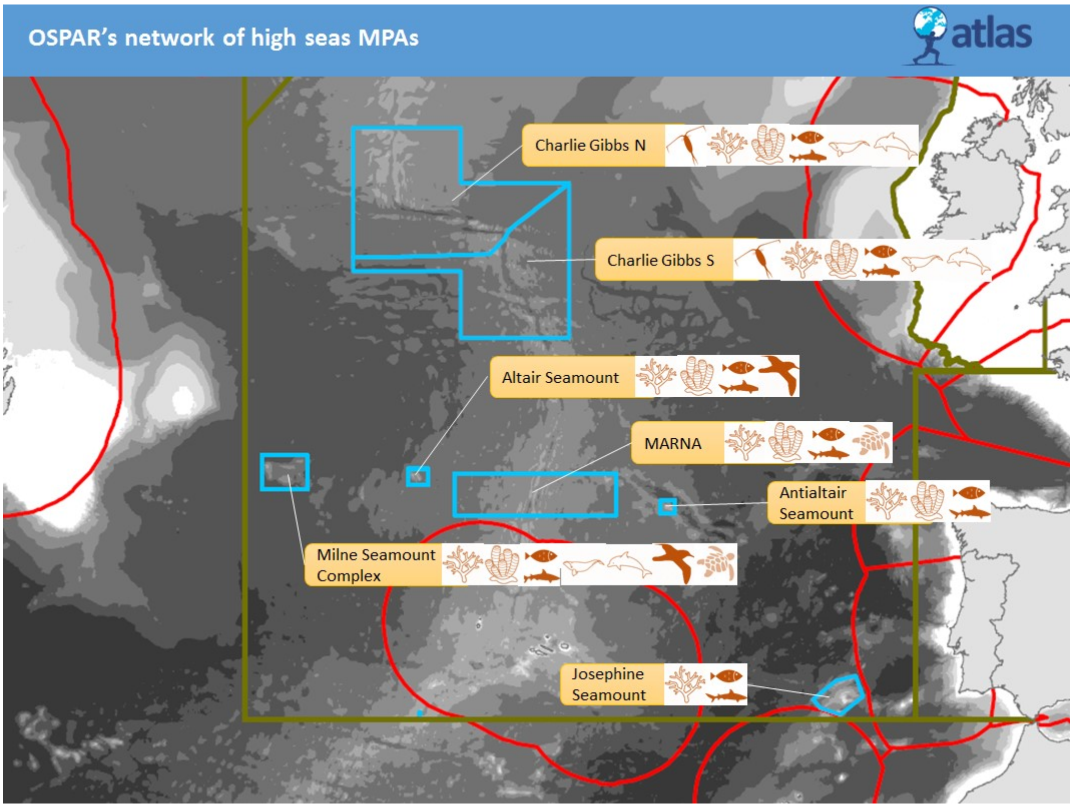

Figure 6.6. OSPAR's network of high seas MPAs. Symbols as in figure 6.5. Refer to Table 6.4. The analysis suggests that all of these ABMTs may be affected by a changing environment (yellow/brown coloration).

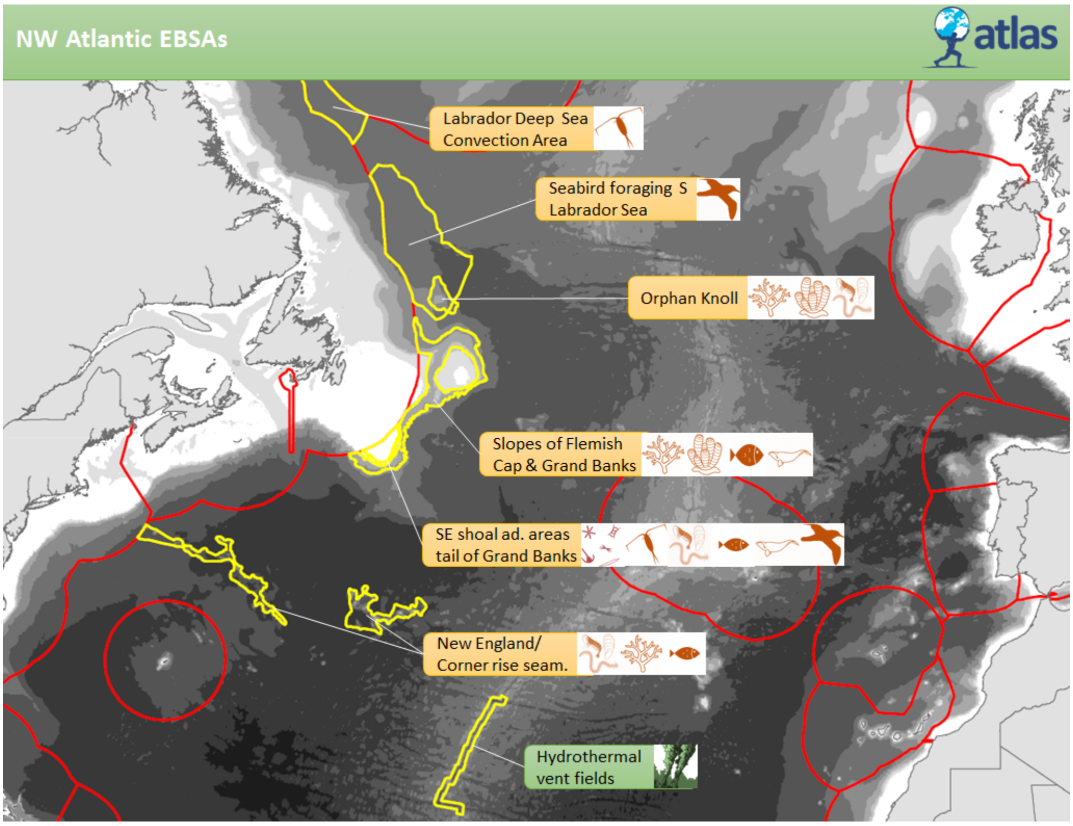

Figure 6.7. NW Atlantic EBSAs. Symbols as in figure 6.5. refer to Table 6.4. The analysis suggests that all but one of these ABMTs (the exception being the hydrothermal vent fields marked in green) may be affected by a changing environment (yellow/brown coloration).

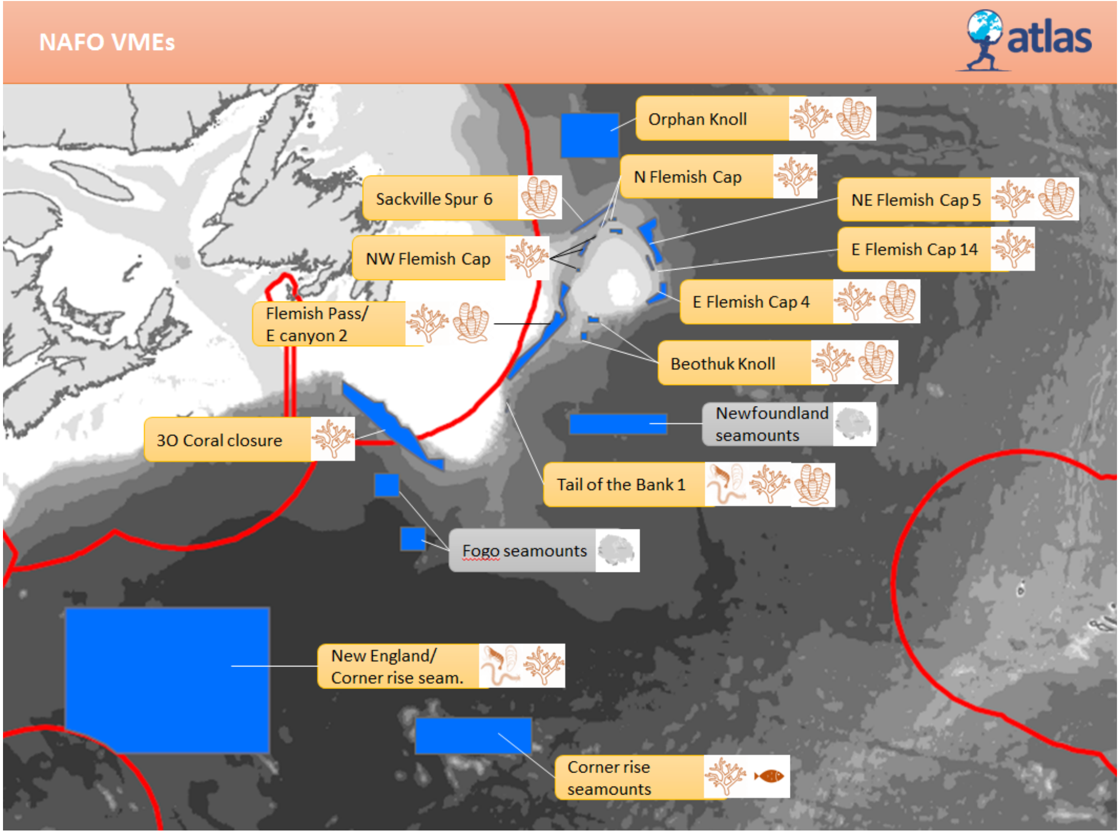

Figure 6.8. NAFO VMEs. Symbols as in figure 6.5. Refer to Table 6.4. The analysis suggests that all of these ABMTs may be affected by a changing environment (yellow/brown coloration).

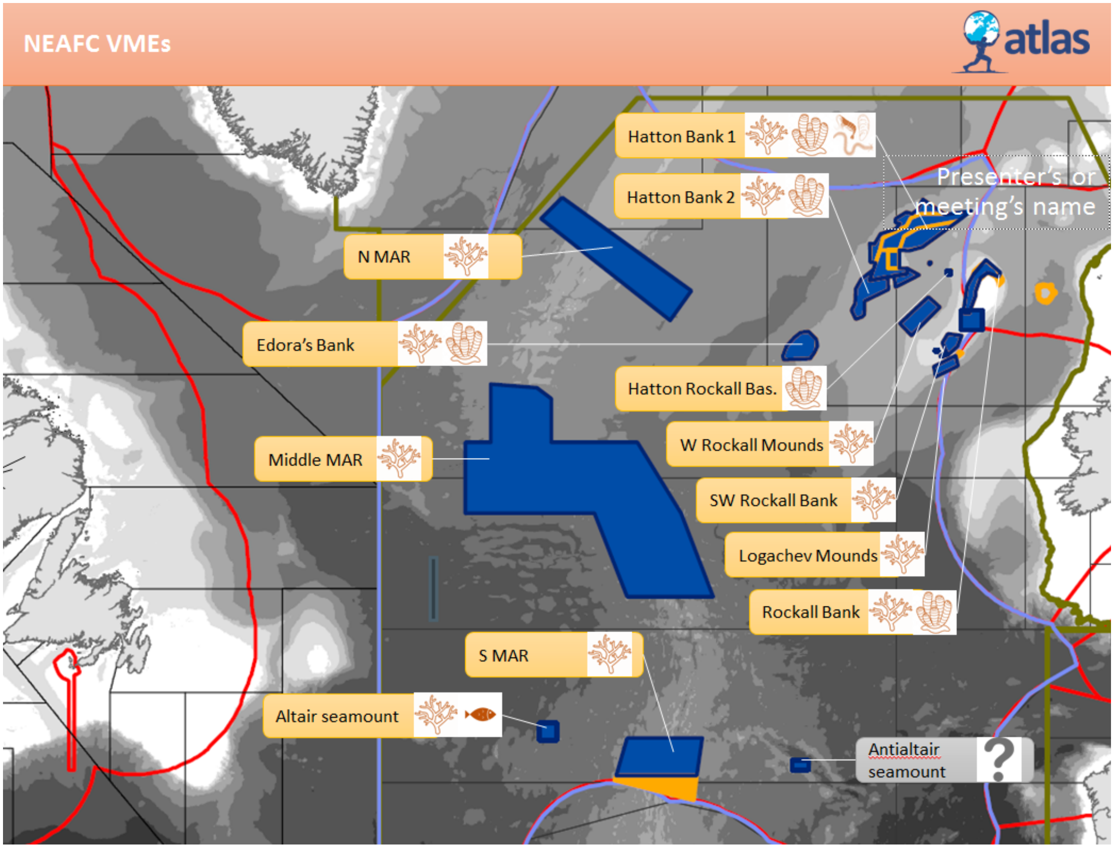

Figure 6.9. NEAFC VMEs. Symbols as in figure 6.5. Refer to Table 6.4. The analysis suggests that all of these ABMTs may be affected by a changing environment (yellow/brown coloration).

With the exception of the hydrothermal vent EBSAs, all of the current MPAs, EBSAs and areas closed to fishing to protect VMEs may be impacted by all of the five climate change variables before 2050. Two of the ABMTs, the seabird foraging area and the Evlanov Seamount (proposed area), were described on the basis of importance to sea birds. The areas themselves will be impacted by climate change as noted, however, for highly mobile species such as birds, the conservation targets can likely be met by relocating to new areas. In the case of attached or species with low mobility, such as the benthic invertebrates, impacts to an area may mean that there are few mitigation options.

We had expected to see more areas in the ABNJ that were unimpacted, or at least impacted at slower rates, allowing for adaptation. The fact that this was not observed in the 5 variables studied may be because the IPCC and other global models are not sufficiently precise for 2050 timelines. This is an important conclusion as the current 2100 projects are too far removed from the urgent need to assess current ABMTs in light of policy targets (such as Aichi Target 11 and SDG Target 14.5) over decadal time scales from 2020 onwards. Other variables not considered specifically here, such as aragonite saturation, will show spatial differentiation in the NW Atlantic by 2099 if not by 2040[222]. Variables that are highly relevant to certain taxa, such as stony corals (*Lophelia pertusa* for example), may give more insight to climate change effects in specific ABMTs established for their conservation. Further, for some variables such as aragonite, refugia may be in shallow water[223,224,225] and conservation may require collaborative efforts between ABNJ and national authorities. This will be an important consideration for future research, which ATLAS will help to address, especially as shallow water areas have increased pressures from other anthropogenic impacts (*e.g.*, pollution) and are more vulnerable to natural disturbances from ice scour, storms etc.

6.5 Properties of populations, habitats and ecosystems which increase resilience of marine systems to climate change

Climate change is expected to affect virtually every aspect of marine ecosystem structure and function from community composition and biogeochemical cycling, to the prevalence of diseases. Climate change will affect populations, habitats, and ecosystems differently depending on their underlying characteristics. A number of properties of populations, habitats, and ecosystems, believed to increase the magnitude of disturbance that an ecosystem can absorb, was put forward by ICES (2011).[226] In Box 6.4. a subset of properties relevant for deep-sea ecosystems is synthesised.

BOX 6.4. Summary of selected ecosystem, habitat, and population properties relevant for resilience (for the complete list cf. ICES, 2011)

ECOSYSTEM PROPERTIES

Connectivity: connections with adjacent and distant ecosystems through the flux of juvenile and adult organisms across ecosystem boundaries (spatial fluxes).

Abundance and/or body size structure of species at upper trophic levels: Changes in resource availability at the bottom of food webs, altering abundances at higher trophic levels.

Species richness: The number of different species in a given community.

Functional redundancy: Species that contribute in equivalent ways to one ecosystem function, (species may be redundant for one ecosystem function but not for others).

HABITAT PROPERTIES

Heterogeneity: the habitat equivalent of the species richness metric.

Foundation species: Organisms that are important in creating and modifying habitats (*e.g.*, mussels in hydrothermal vents).

Ecosystem engineer: organism that creates, builds or modifies habitats (*e.g.*, corals, bioturbators).

Disturbance: spatial extent and magnitude

Bathymetry, topography and rugosity: Variations in the heights of surfaces.

Habitats supporting critical life stages: *e.g.* breeding sites.

POPULATION PROPERTIES

Connectivity: key characteristic with direct relevance to the scale and spacing of MPA networks.

Dependence on critical habitats: *e.g.* species dependent on others particularly vulnerable to CC.

Sensitivity to environmental conditions: vulnerability to changing environmental conditions.

Flexibility in migration routes: particularly whales, sea turtles, tunas, swordfish, sharks, and seabirds.

Population size and age structure: positively correlated with population connectivity within MPA networks

Geographic distribution: may be modified due to exploitation and other human influences.

Number of population subunits (metapopulation structure): measure of variability.

Phenology: periodic (seasonal and interannual) succession of life cycle events (example, temperature and photoperiod that influence the timing of biological cycles)

Table 6.9. presents the main traits expected to confer resilience to climate change impacts in each of the ABMTs considered in this study (OSPAR MPAs, CBD EBSAs, FAO VMEs). Some of the underlying assumptions are that corals and sponges can be equated to upper trophic levels[227] and that both groups can be considered foundation species and ecosystem engineers.

There are many caveats to constructing and interpreting such a table. First, there is no weighting of traits, either within or across the ecosystem, habitat and population levels. Further elaboration or ranking of these areas could weight ecosystem level resilience higher than that of habitats and lastly, populations. For each ABMT, traits associated with both high and low resilience occur. This is an expected result but we have not considered how to trade-off such traits, other than our down-ranking approach. Also, the presence of a trait may have positive or negative resilience consequences, and their interpretation can be influenced by perspective: that is resilience for the component itself or for the environment in which it lives (*e.g.*, removal of foundation species would result in a loss of biodiversity so dependence on them can be viewed as a negative resilience factor, while presence would be positive for the species itself). Lastly, the table describes the properties of each area based on current knowledge and does not explicitly link those properties to the climate change stressors (figure 6.1). The latter was done in the previous step; consequently hydrothermal vents will have characteristics that relate to resilience, but it was already established that the pressure of climate change is not expected to impact such areas.

With so many challenges and surmises the value of our table can readily be questioned. However, we feel that by going through this process we have identified important knowledge gaps and research directions on how to synthesize such data in order to fully evaluate the intrinsic properties of ecosystems to adapt to climate change.

We provide a subjective summary of the assessment of those traits under High and Low Resilience scenarios and then apply a further subjective assessment of each ABMT for their resilience to climate change based on the ecosystem components used to justify their selection (Tables 4.4.-4.7.). The presence of 10 traits across Population, Habitat and Ecosystem levels were thought to confer resilience, while the presence of 7 traits were associated with a lower resilience to climate change (Table 6.9). All AMBTs had a combination of positive and negative resilience factors and were ranked.

Table 6.9. Traits expected to confer resilience to climate change impacts in each of the ABMTs considered in this study (OSPAR MPAs, CBD EBSAs, FAO VMEs) with a subjective overall evaluation of resilience. -: no; X: yes, well supported; ?: unknown.

	Ecosystem				Habitat						Population							
	Connectivity	Abundance & size structure of upper trophic levels	Species richness	Functional redundancy	Heterogeneity	Foundation spp.	Ecosystem engineers	Disturbance	Bathymetry, topography and rugosity	Habitats supporting critical life stages	Connectivity	Dependence on critical habitats	Sensitivity to environmental conditions	Flexibility in migration routes	Population size and age structure	No. of population subunits or metapopulations	Phenology	Subjective Resilience Score (H, M, L)
High Resilience	X	-	X	X	X	-	-	X	X	-	X	-	-	X	X	X	-	H
Low Resilience	-	X	-	-	-	X	X	-	-	X	-	X	X	-	-	-	X	L
CGN MPA	X	X	X	?	X	X	X	?	X	X	X	X	X	?	?	?	X	M
CGS MPA	X	X	X	?	X	X	X	?	X	X	X	X	X	?	X	?	X	M
Milne seamount MPA	?	X	X	?	X	X	X	?	X	X	?	X	X	?	?	?	?	L
Altair seamount MPA	?	?	?	?	?	?	?	?	X	X	?	X	?	?	?	?	?	L
Altair Seamount VME	-	?	?	?	X	?	?	?	X	?	?	?	?	?	?	?	?	L
Antialtair MPA	?	?	?	?	X	?	?	?	X	?	?	?	?	?	?	?	?	L
Antialatir seamount VME	?	?	?	?	X	?	?	?	X	?	?	?	?	?	?	?	?	L
MARNA	X	X	X	?	X	X	X	?	X	X	X	X	X	?	?	?	X	L
Josephine Seamount	?	X	X	X	X	X	X	?	X	X	?	X	X	?	?	?	X	L
Labrador Deep Sea Convection Area	X	X	?	?	?	X	?	X	X	?	?	X	X	?	?	?	X	L
Seabird foraging zone in S Labrador	X	X	X	X	?	-	-	?	-	X	X	X	X	?	?	?	X	L
Orphan Knoll EBSA	-	?	?	?	X	X	X	?	X	?	?	?	?	?	?	?	?	L
Orphan Knoll VME	X	?	X	?	X	X	X	?	X	?	?	?	X	?	?	?	?	L
Slopes Flemish Cap	?	?	?	?	X	X	X	?	X	X	?	X	X	?	?	?	?	L
SE Shoal and Adjacent areas	-	X	X	X	X	X	?	?	X	X	?	X	X	-	?	?	?	L
New England and Corner Rise Seamount Chains	X	?	X	?	X	X	X	?	X	X	X	X	X	?	?	?	?	L
Hydrothermal vent fields	-	X	X	?	X	X	?	?	X	X	?	X	X	-	?	?	-	L
Fogo Seamounts	X	?	?	?	X	?	?	?	X	?	?	?	?	?	?	?	?	L
Corner Rise Seamounts	X	?	X	?	X	X	X	?	X	X	?	X	X	?	?	?	?	L
Newfoundland Seamounts	X	?	?	?	X	X	?	?	X	?	?	?	?	?	?	?	?	L
New England Seamounts	X	?	X	?	X	X	?	?	X	?	?	?	?	?	?	?	?	L

	Ecosystem				Habitat						Population							
	Connectivity	Abundance & size structure of upper trophic levels	Species richness	Functional redundancy	Heterogeneity	Foundation spp.	Ecosystem engineers	Disturbance	Bathymetry, topography and rugosity	Habitats supporting critical life stages	Connectivity	Dependence on critical habitats	Sensitivity to environmental conditions	Flexibility in migration routes	Population size and age structure	No. of population subunits or metapopulations	Phenology	Subjective Resilience Score (H, M, L)
3O Coral closure	?	X	X	?	?	X	X	?	?	?	?	?	?	?	?	?	?	L
Tail of the Bank 1	-	X	X	?	?	X	X	?	?	?	?	X	X	-	?	?	?	L
Flemish Pass/Eastern Canyon 2	X	X	X	?	X	X	X	?	X	?	?	X	X	-	?	?	?	L
Beothuk Knoll 3	?	X	X	?	X	X	X	?	X	?	?	X	X	-	?	?	?	L
Beothuk Knoll 13	?	X	X	?	X	X	X	?	X	?	?	X	X	-	?	?	?	L
E Flemish Cap 4	?	X	X	?	X	X	X	?	X	?	?	X	X	-	?	?	?	L
NE Flemish Cap 5	?	X	X	?	X	X	X	?	X	?	?	X	X	-	?	?	?	L
Sackville Spur 6	?	X	X	?	-	X	X	?	X	?	?	X	X	-	?	?	?	L
N Flemish Cap 7, 8, 9	?	X	X	?	-	X	X	?	X	?	?	X	X	-	?	?	?	L
NW Flemish Cap 10, 11, 12	?	X	X	?	-	X	X	?	X	?	?	X	X	-	?	?	?	L
E Flemish Cap 14	?	X	X	?	X	X	X	?	X	?	?	X	X	-	?	?	?	L
N MAR Area	X	X	X	?	X	X	X	?	X	?	?	X	X	-	?	?	?	L
Middle MAR Area	X	X	X	?	X	X	X	?	X	?	?	X	X	-	?	?	?	L
S MAR Area	X	X	X	?	X	X	X	?	X	?	?	X	X	-	?	?	?	L
Hatton Bank	?	X	X	?	X	X	X	X	X	X	?	X	X	-	?	?	?	L
Rockall Bank	?	X	X	?	X	X	X	X	X	X	?	X	X	?	?	?	?	L
Logachev Mounds	X	X	X	?	X	X	X	X	X	X	?	X	X	?	?	?	?	L
W Rockall Mounds	X	X	X	?	X	X	X	X	X	X	?	X	X	?	?	?	?	L
Edora’s Bank	X	X	X	?	X	X	X	?	X	X	?	X	X	-	?	?	?	L
SW Rockall Bank	?	X	X	?	X	X	X	?	X	X	?	X	X	-	?	?	?	L
Hatton-Rockall Basin	X	X	X	?	X	X	X	?	X	X	?	X	X	-	?	?	?	L
Hatton bank 2	?	X	X	?	-	X	X	?	X	X	?	X	X	-	?	?	?	L

We identify many knowledge gaps (Table 6.9) which should be filled in order to provide an objective evaluation of resilience. In particular Population-level traits of deep sea species identified in ABMT were particularly data deficient. Conversely, most ABMT had some level of information on Habitat-level traits, particularly on “Bathymetry, topography and rugosity” which varied in quality from low resolution GEBCO bathymetry (*e.g.*, Fogo Seamounts) to multibeam bathymetric data (Flemish Cap). None of the ABMT ranked as highly resilient (H) against climate change as measured herein (Table 6.9). However the Charlie Gibbs Fracture Zone MPAs (North and South) received a medium resilience score, largely due to the comprehensive nature of information from that area compared with others.

6.6 Key findings

What is the future of current ABMTs in the North Atlantic in the framework of future scenarios and Blue Growth?

The future of current ABMTs in the North Atlantic looks bleak. The availability of refugia is very limited. Species distribution regime shifts will likely be compounded by nutrient flux and cycling changes, pollutant toxicity increases, reduction in zooplankton productivity and possible invasive species distribution/dominance. ATLAS can help by validating theories on 'ecosystem switches'. The current IPCC models are designed to constrain heat movement at a large scale and inform longer-term future scenarios. To evaluate priorities for ABMTs high skill smaller scale predictions for the next 2 to 5 decades are needed. Current climate models are not robust or accurate enough in the short term (*i.e.* over the next 30 years), they are more robust up to 2100. ATLAS experts suggest a more detailed look at vertical stratification, upper salinity, currents and mixing, seasonal range of temperature and other variables (*e.g.* magnitude and depth of penetration of SST), limiting nutrients, ice cover and atmospheric variables (wind, heat flux, precipitation-evaporation, NAO).

How are these areas going to be affected?

They will become significantly less hospitable for those species for whose protection they have been identified. The subjective analysis presented here shows high levels of impact and only limited resilience. This will be compounded by other factors. For example, present and future aragonite saturation with depth will heavily impact stony coldwater corals. Guinotte *et al*. (2006) forecast that the majority of deep-water corals (70%) will be in undersaturated waters by 2100[228]. The picture presented is one of whole ecosystem change due to a combination of climate change and ocean acidification effects, further complicated by trophic mismatches, competition and food supply. More detailed knowledge of these ABMTs will raise objectivity for resilience considerations and a more detailed case by case evaluation may be appropriate.

When are impacts going to be felt?

ATLAS experts have observed that temporal scale is crucial as well as spatial scale. Even if we can predict where future habitats will be there is no guarantee that some species such as coldwater corals will be able to adapt until much later whereas mobile species such as seabirds will show much quicker response to change because they will follow food supply. More objective assessment can only be made where more comprehensive information is available. Impacts will be felt within the next 20 years at a rate likely more rapid than many species can adapt and resilience is low. ATLAS can help by developing indicators for Good Environmental Status (GES) in ABNJ. Monitoring should provide early warning.

Will current protections remain useful/relevant in the face of a changing environment?

Some will but on the basis of this analysis the majority are likely to become less fit for purpose or redundant. The ATLAS community suggested to differentiate between ABMTs recognised for mobile pelagic features (*e.g.* oceanographic fronts) and sessile benthic fauna associated with fixed geomorphic features (*e.g.* seamounts). For the former, it is clear that the planktonic ecosystem of the North Atlantic is changing rapidly and this may have profound impacts on the distribution of higher order pelagic species for which several ABMTs have been recognised. The northward shift of warm water plankton and a similar retreat of coldwater plankton has implications for primary production hot spots and fish stocks. Evaluation of these ABMTs may need to consider repositioning, for example based on seabird tracking data, with a need for more pelagic ABMTs in northern latitudes. For fixed benthic features, more influenced by topography, relocating to another similar feature may be possible in some cases. However, at the same time temperature rise will have a disproportionate influence on Arctic and sub-Arctic waters with problems for specific species. ATLAS can help by developing eDNA techniques to assess species presence and applying these more generally beyond 'proof of concept' to support biodiversity monitoring[229].

How can we build a network of resilient ABMTs in the North Atlantic?

This may require a profound review of the concept of ecosystem-based management with a need for adaptive ABMTs and a significant reduction of other stressors. Options include introducing strict levels of protection for ABNJ in line with the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) General Framework for MPAs[230], with an emphasis on scientific reference areas, and seeking to protect higher percentages of three dimensional ocean space. For example, IUCN World Conservation Congress 2016, Resolution 50, reiterated arguments put forward previously, advocating the designation and implementation of “at least 30% of each marine habitat in a network of highly protected MPAs and other effective area-based conservation measures, with the ultimate aim of creating a fully sustainable ocean, at least 30% of which has no extractive activities”[231]. We may also need to consider ABMTs for a ‘second order’ of biodiversity focused on protection of ecological function rather than key species (*i.e.* which areas can continue to support a range of trophic layers). ATLAS can help by developing protocols for predictive mapping of species and habitats that can be used for suitability scenarios building on existing work (*e.g.* Ross and Howell, 2012[232]) and by factoring these into future marine spatial planning considerations.

7 Recommendations

Principal recommendations on priorities for an expert assessment on North Atlantic EBSAs, VMEs and MPAs in ABNJ are that:

- Spatial heterogeneity in the North Atlantic results in a need to 'future proof' ABMTs, emphasising resilience and refugia (+ ecosystem services function), to protect apex predators, confer system stability, increase population size and provide stepping stones for climate migration: making this explicit is a key role for ATLAS. Key questions are:
    - What is the rate of change for the features for which current suite of ABMTs have been developed?
    - Are there locations that will remain relevant (*i.e.* resilient to changes in environmental gradients in 20-50 years)?
    - Which models will demonstrate viable populations in terms of connectivity (noting the difference between genetic connectivity and physical migratory connectivity)?
- Confidence in the effectiveness and reliability of climate models at a suitable spatial scale is needed to be able to make predictions about the robustness of areas with regard to climate change and ocean acidification using a case-by-case analysis. Climate models with high skill for a 20-50 year time horizon incorporating specific scale oceanographic variables are needed.
- It is important to recognise a degree of commonality of purpose and consider these three categories of ABMTs selected here collectively as a "network" in order to:
    - Evaluate levels of connectivity to see where new/alternative areas are best located.
    - Draw up an Atlantic-wide assessment and monitoring programme to monitor the state of these designations
    - Use any expert assessment as an opportunity to work towards meeting Aichi 11 and SDG 14.5, including a broad interpretation of OECMs as a contribution to exceeding 10% MPA coverage
    - Draw the attention of results to those responsible for the BBNJ Implementing Agreement, acknowledging implications beyond ABMTs to other elements of the BBNJ 'package' (i.e., more stringent EIAs in climate change affected areas likely to be subject to significant and cumulative impacts).

- Use these findings to contribute to Marine Spatial Planning decisions recognising that climate change impacts may dominate certain situations: protecting 'lucky spots' and areas of high resilience where human uses should be discouraged and enhanced scientific study prioritised.

In addition to evaluating the existing suite of ABMTs future consideration must be given to gaps and omissions. These include the need for additional ABMTs in under-represented biogeographic regions and/or features yet to be considered. For example, ATLAS has considered marine ecosystems and biological features of the Gazul mud volcano (Gulf of Cadiz) [3] which may qualify as a VME and/or EBSA and is also a location within the OSPAR Maritime Area that may meet the OSPAR MPA criteria[233].

[3] Rueda *et al*. (2017) reported three species of reef framework-forming corals, coral gardens including solitary scleractinians, gorgonians and antipatharians, as well as deep-sea sponge aggregations and chemosynthesis-related structures.

Annexes

Annex I – Aichi Targets

STRATEGIC GOAL A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society

Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

Target 2: By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.

Target 3: By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.

Target 4: By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

STRATEGIC GOAL B: Reduce the direct pressures on biodiversity and promote sustainable use

Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

Target 6: By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.

Target 7: By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

Target 8: By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.

Target 9: By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

Target 10: By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

STRATEGIC GOAL C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

Target 11: By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

Target 12: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Target 13: By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

STRATEGIC GOAL D: Enhance the benefits to all from biodiversity and ecosystem services

Target 14: By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

Target 16: By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.

STRATEGIC GOAL E: Enhance implementation through participatory planning, knowledge management and capacity building

Target 17: By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.

Target 18: By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.

Target 19: By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

Target 20: By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.

Annex II – OSPAR High Seas MPAs

Table II.1. Charlie-Gibbs North High Seas MPA[234]

Designation	Charlie-Gibbs North High Seas MPA (water column)
Features	**Size:** 178 651 km² Located in ABNJ (overlays subarea of continental shelf submission of Iceland) **Biogeographic region:** cool-temperate Atlantic waters (51,40-55,00ºN; 27,00-37,00ºW) Covers N part of Mid-Atlantic Ridge (MAR); comprises section of the Reykjanes Ridge, N of the CGFZ; Extends from the central crest of the ridge along the slopes and rifts on either side of the ridge axis into waters with depths of 3500 m or more. The MAR has a profound role in the circulation of the water masses in the North Atlantic. The complex hydrographic setting around the MAR in general and the presence of the ridge itself leads to enhanced vertical mixing and turbulence that may result in areas of increased productivity over the MAR The high seas MPA incorporates waters superjacent to part of a topographically and hydrographically especially complex section of the MAR and is expected to be home to diverse and interesting deep-sea fauna
Benthic/ Demersal	**Cold-water corals** (*Lophelia pertusa, M. oculata, Solenosmilia variabilis)* (range 772-2355 m, highest freq. 800-1400 m). 27 of 40 coral taxa were octocorals (gorgonacea were the most diverse). Very little overlap in spp. composition of the coral fauna in the sampling areas N, near and Sof the CGFZ. *Lophelia pertusa* and *Solenosmilia variabilis* were found to act as the main structure corals; *Solenosmilia* was probably most common in the deeper parts of the study areas. All *Lophelia/Solenosmilia* colonies were relatively small with a maximum diameter of less than 0.5 m. More megafaunal occurred in areas where corals dominated compared to areas without coral. Typical taxa in co-occurrence with *Lophelia*: crinoids, certain sponges, the bivalve *Acesta excavata*, and squat lobster. **Deepwater sponge aggregations**: likely occurrence. **Demersal (benthopelagic) fish fauna:** estimations of c. 80 spp. including roundnose grenadier (*Coryphaenoides rupestres*) and alfonsino (Beryx splendens). 68 spp. of mainly mesobenthopelagic bathyal fishes associated to the seamounts (within the MPA), including 44 spp. of deepwater sharks, such as as Chlamydoselachidae, Pseudotriakidae, Scyliorinidae and Squalidae, including Leafscale gulper shark (*Centrophorus squamosus*), Gulper shark (*C. granulosus*) and Portuguese dogfish (*Centroscymnus coelepis*). Giant redfish (*Sebastes marinus*), tusk (*Brosme brosme*) and Greenland halibut (*Reinhardtius hippoglossoides*) dominant in longline catches. Largest catches of Greenland halibut on and in the vicinity of coral reefs at approx.. 1600 m (extremely small catches in coral-free areas). Enhanced near ridge demersal fish biomass above the MAR (*e.g.*, blue ling and roundnose grenadier spawning aggregations on the northern MAR)
Pelagic	**Pelagic productivity considered to be very high:** deep-scattering layers, mostly around 300-800 m. Abundant taxa incl. fish (Myctophidae), shrimps, euphausiids, cephalopods, and medusae. **Dominant zooplankton:** crustaceans, ctenophores, siphonophores, appendicularians, medusae and chaetognaths; Higher egg production rates of *Calanus finmarchicus* in the area; this boreal copepod sp. is one of the most important zooplankton components of the N Atlantic, being the basis of one major food pathway in the pelagic ecosystem through small mesopelagic fish and shrimp and baleen whales (used as indicator of pelagic productivity). **Fish:** relatively high pelagic fish diversity (99 spp. from 43 families); inhabited by highly migratory fish species such as tunas, billfishes and epipelagic sharks **Cephalopods:** c. 53 spp. (29 families). The squid *Gonatus* spp. occurs in this N area. **Cetaceans:** 13 spp. identified. Pilot whale (*Globicephala melas*), and white-sided dolphin *Lagenorhynchus acutus*) only detected on the N; The ecosystem appears to be of particular importance to sei and sperm whales. Likely occurrence of Blue Whale (*Balaenoptera musculus*)
Epipelagic (0-200 m)	**General circulation well understood:** the warm N Atlantic current flowing NE from the subtropical gyre in the SW Atlantic towards the European shelf with 2-4 branches crossing the MAR. Where the warm, saline N Atlantic water meets the cold, less saline water of the subpolar gyre from the Labrador and Irminger Seas, the Sub-Polar Front is created, and is a permanent feature. The meandering of the Sub-Polar Front coincides with temporal variation in the character and spatial distribution of the water masses and frontal features. This front is one of the major oceanic features in the OSPAR maritime area, with elevated abundance and diversity of many taxa, including an elevated standing stock of phytoplankton and biological production and biomass in the pelagial. Generally limited surface production **Seabirds**: 22 spp. Only the northern fulmar (*Fulmarus glacialis*), great shearwater (*Puffinus gravis*) and Cory´s shearwater (*Calonectris diomedea*) were observed by the hundreds. The area may also be important for great shearwater (*Puffinus gravis*) **Seaturtles:** probable occurrence of Leatherback Turtle (*Dermochelys coriacea*)
Management measures[235]	**Awareness raising** (*e.g.* incl. MPA in sea charts/maps; encourage vessels to comply with management measures); **Information building** (building/sharing and reporting information/knowledge (including scientific and technical) on biodiversity and ecosystems of this MPA and impacts of human activities taking place in this MPA; **Marine science**: promote application of "OSPAR Code of Conduct for responsible Marine Research in the deep seas and high seas of the OSPAR area" (OSPAR Agreement 2008-1) in this MPA; encourage, support and initiate scientific research projects/programmes to enhance knowledge base of the site, impacts from human activities, and solutions to achieve conservation objectives; encourage inclusion of this MPA as reference area in scientific research programmes on CC and the oceans; identify suitable mechanisms for monitoring the

Designation	Charlie-Gibbs North High Seas MPA (water column)
	achievement of this MPA's conservation objectives; identify activities and mitigating actions to achieve such objectives. **New Developments**: divulge plans for human activities in this MPA, and for measures outside the area that may be potentially conflicting with the conservation objectives and likely to cause significant impact to the ecosystems of the MPA; ensure that, in such cases, an Environmental Impact Assessment (EIA) or Strategic Environmental Assessment (SEA) is carried out, and that appropriate measures are taken; engage stakeholders in planning new activities and assessing their potential impacts on this MPA; use best-available scientific advice when planning new activities and assessing their potential impacts on this MPA. **Third Parties**: engage with third parties (incl. relevant international organisations) to promote the delivery of the MPA's conservation objectives and to encourage application of the above programmes and measures.
Vulnerabilities (activities)	**Deep-sea and high-seas Fisheries (currently the most damaging industry operating in the NE Atlantic):** - Estimated high number of lost gear potentially ghost-fishing for a long time (extensive long-lining activities may have led also to substantial coral bycatch) - Structural sponge habitat extremely vulnerable to trawling. - High vulnerability of fish populations inhabiting the seamounts to overfishing, particularly for deepwater spp. with a retarded maturation and low fecundity: serial depletion of individual fishing sites and stocks (quick exhaustion of redfish and alfonsino when commercially fished in the early 1990s and rather low overall abundance of potentially commercially relevant fish stocks on the seamounts of the MAR being); speculations about a changing balance between the spp. of the fish community. In terms of sharks, *C. squamosus* and *C. coelolepis* stocks on the northern MAR are also considered to be depleted. - Threats from future fishing activity to this area are high.
BG opportunities	**Science:** not affected by any management regime (not a direct BG field) **Tourism:** No tourism present **Bioprospection:** Extent of the activity within the proposed area is currently unknown; in the future his could become a significant activity with implications for the conservation objectives of the MPA. **Mining:** Subject to ISA licensing, no exploration or exploitation plans known as yet. **Transport:** Unlikely to be affected.
Gaps/ uncertainties	The area is important for spp., habitats/biotopes and ecological processes that appear to be under immediate threat or subject to rapid decline as identified by the OSPAR (Texel-Faial) selection process.). There is insufficient knowledge to prove the special importance of the MAR section to the life and success of populations and communities. Several spp. of elasmobranchs occur in the MPA and, as a group, elasmobranchs are acknowledged to be sensitive to over-exploitation, but there is no information to indicate that populations in this area have been depleted.

Table II.2. Charlie-Gibbs South High Seas MPA[236,237]

Designation	Charlie-Gibbs South High Seas MPA
Features	**Size:** 145,420 km² **Biogeographic region:** cool-temperate Atlantic waters (49,00-52,20ºN; 29,77-37,00ºW) Mid-Atlantic Ridge (MAR) S of the CGFZ. Two pronounced deep rift valleys at 32.25°W and 31.75°W, and two further fracture zones (Faraday and Maxwell Fracture Zones, at 50°N and 48°N respectively) create an enormous topographic – and fairly unknown – ecological complexity. The influence of the subpolar front on the ecosystem near the CGFZ creates differences between the areas north and south of the frontal zone on the ridge. The subpolar front acts as a biogeographic boundary for several species, reflecting vertically and horizontally the different water masses, which are warmer and more saline S of the CGFZ. Extends from the central crest of the ridge along the slopes and rifts on either side of the ridge axis into waters with depths of 3500 m or more. The MAR has a profound role in the circulation of the water masses in the North Atlantic. The complex hydrographic setting around the MAR in general and the presence of the ridge itself leads to enhanced vertical mixing and turbulence that may result in areas of increased productivity over the MAR The high seas MPA incorporates waters superjacent to part of a topographically and hydrographically especially complex section of the MAR (*e.g.* Søiland *et al*., 2008) and as such is expected to be home to diverse and interesting deep-sea fauna
Benthic/ Demersal	48% of the 150 spp. identified occurred only to the W of the ridge and 19% of the spp. were restricted to the eastern Atlantic. **Cold-water corals** (*Lophelia pertusa, M. oculata, S. variabilis)* (range 772-2355 m, most commonly bet. 800-1400 m). 27 of 40 coral taxa were octocorals (gorgonacea were the most diverse). Very little overlap in spp. composition of the coral fauna in the sampling areas N, near and Sof the CGFZ. *Lophelia/Solenosmilia* were rare on video of S site. The diversity of corals is higher in the S area. **Deepwater sponge aggregations**: likely occurrence. **Demersal (benthopelagic) fish fauna:** estimations of c. 80 spp. including roundnose grenadier (*Coryphaenoides rupestres*) and alfonsino (Beryx splendens), and 44 spp. of deepwater sharks, such as as Chlamydoselachidae, Pseudotriakidae, Scyliorinidae and Squalidae, including Leafscale gulper shark (*Centrophorus squamosus*), Gulper shark (*C. granulosus*) and Portuguese dogfish (*Centroscymnus coelepis*). Commercially interesting spp. are known to for temporal agregations for mating and spawning over the summits and/or flanks of seamounts and the peaks of the MAR, respectively. In this S MPA subtropical spp. dominate : golden eye perch (*Beryx splendens*) and cardinal fish (*Epigonus telescopus*) Enhanced near ridge demersal fish biomass above the MAR (*e.g.,* blue ling and roundnose grenadier spawning aggregations on the northern MAR) 68 spp. of mainly mesobenthopelagic bathyal fishes associated to the seamounts of the northern MAR (within the MPA), including 44 spp. of deepwater sharks
Pelagic	**Pelagic productivity considered to be very high:** deep-scattering layers, mostly around 300-800 m. Abundant taxa incl. fish (Myctophidae), shrimps, euphausiids, cephalopods, and medusae. **Dominant zooplankton**: crustaceans, ctenophores, siphonophores, appendicularians, medusae and chaetognaths; Higher egg production rates of *Calanus finmarchicus* in the area; this boreal copepod sp. is one of the most important zooplankton components of the N Atlantic, being the basis of one major food pathway in the pelagic ecosystem through small mesopelagic fish and shrimp and baleen whales (used as indicator of pelagic productivity). Different communities N and S of the FZ. **Fish:** elevated primary productivity; inhabited by highly migratory fish species such as tunas, billfishes and epipelagic sharks. Important stock of the redfish *Sebastes mentella* **Cephalopods:** c. 53 spp. (29 families) for the entire CBFZ (N/S). The highest no. of spp. occurred in this S area. One species of squid (*Heteroteuthis dispar*) was only found here. **Cetaceans:** 13 spp. identified. Common dolphin (*Delphinus delphis*) and striped dolphins (*Stenella coeruleoalba*) found only in S area; The ecosystem appears to be of particular importance to sei (*Balaenoptera borealis*) and sperm whales (*Physeter macrocephalus*). Likely occurrence of Blue Whale (*Balaenoptera musculus*)
Epipelagic (0-200 m)	Elevated abundance and diversity of many taxa, including an elevated standing stock of phytoplankton and biological production and biomass in the pelagial. Generally limited surface production **Seabirds**: 22 spp. Only the northern fulmar (*Fulmarus glacialis*), great shearwater (*Puffinus gravis*) and Cory´s shearwater (*Calonectris diomedea*) were observed by the hundreds. The area may also be important for great shearwater (*Puffinus gravis*) **Seaturtles:** probable occurrence of Leatherback Turtle (*Dermochelys coriacea*)
Management measures[238]	**Awareness raising** (*e.g.* incl. MPA in sea charts/maps; encourage vessels to comply with management measures); **Information building** (building/sharing and reporting information/knowledge (including scientific and technical) on biodiversity and ecosystems of this MPA and impacts of human activities taking place in this MPA; **Marine science**: promote application of "OSPAR Code of Conduct for responsible Marine Research in the deep seas and high seas of the OSPAR area" (OSPAR Agreement 2008-1) in this MPA; encourage, support and initiate scientific research projects/programmes to enhance knowledge base of the site, impacts from human activities, and solutions to achieve conservation objectives; encourage inclusion of this MPA as reference area in scientific research programmes on CC and the oceans; identify suitable mechanisms for monitoring the achievement of this MPA's conservation objectives; identify activities and mitigating actions to achieve such objectives. **New Developments**: divulge plans for human activities in this MPA, and for measures outside the area that may

Designation	Charlie-Gibbs South High Seas MPA
	be potentially conflicting with the conservation objectives and likely to cause significant impact to the ecosystems of the MPA; ensure that, in such cases, an Environmental Impact Assessment (EIA) or Strategic Environmental Assessment (SEA) is carried out, and that appropriate measures are taken; engage stakeholders in planning new activities and assessing their potential impacts on this MPA; use best-available scientific advice when planning new activities and assessing their potential impacts on this MPA. Third Parties: engage with third parties (incl. relevant international organisations) to promote the delivery of the MPA's conservation objectives and to encourage application of the above programmes and measures.
Vulnerabilities (activities)	Deep-sea and high-seas Fisheries: - Estimated high number of lost gear potentially ghost-fishing for a long time (extensive longlining activities may have led also to substantial coral bycatch) - Structural sponge habitat extremely vulnerable to trawling. - High vulnerability of fish populations inhabiting the seamounts to overfishing, particularly for deepwater spp. with a retarded maturation and low fecundity: serial depletion of individual fishing sites and stocks (there are reports about the quick exhaustion of redfish and alfonsino when commercially fished in the early 1990s and about the overall abundance of potentially commercially relevant fish stocks on the seamounts of the MAR being rather low) and speculations about a changing balance between the spp. of the fish community. In terms of sharks, *C. squamosus* and *C. coelolepis* stocks on the northern MAR are also considered to be depleted. - Threats from future fishing activity to this area are high.
BG opportunities	Science: scientific research (not a direct BG field) Tourism: Highly unlikely Bioprospection: No info at present; in the future his could become a significant activity with implications for the conservation objectives of the MPA. Mining: Subject to ISA licensing, no exploration or exploitation plans known as yet. Transport: Unlikely to be affected.
Gaps/ uncertainties	The area is important for spp., habitats/biotopes and ecological processes that appear to be under immediate threat or subject to rapid decline as identified by the OSPAR (Texel-Faial) selection process.). There is insufficient knowledge to prove the special importance of the MAR section to the life and success of populations and communities. Several spp. of elasmobranchs occur in the MPA and, as a group, elasmobranchs are acknowledged to be sensitive to over-exploitation, but there is no information to indicate that populations in this area have been depleted. The diversity of the Mid-Atlantic Ridge in general has been understudied

Table II.3. Milne Seamount Complex MPA[239]

Designation	Milne Seamount Complex MPA
Features	**Size:** 20,913 km^2 **Biogeographic region:** cool-temperate Atlantic waters (44.18-45.30°N; 39.10-41.22°W) W of the Mid-Atlantic Ridge. Depth range 500 - >3500 m. MPA boundaries incorporate all areas <3500 m deep, *i.e.*, those areas accessible to fishing vessels. The MPA includes seamount habitat, listed as a priority, threatened or declining habitat by OSPAR.
Benthic/ Demersal	Benthopelagic habitats and associated communities (epibenthos and its hard and soft bottom sediment habitats): no available information, but significant stand of coral (coral gardens and *Lophelia pertusa* reefs) and other bottom living organisms (such as deep-sea sponge aggregations) are expected to occur. Deep water elasmobranchs. Infauna of the soft sediment benthos incl. threatened/declining spp. and habitats. Habitats associated with seamounts.
Pelagic	**Fish**: Fish populations, including tuna, billfishes and several sharks spp. **Cetaceans**: historical Sperm whale (*P. macrocephalus*) data show that this sp. was once caught within and around the MPA and it is likely that individuals still frequent the area. Blue whale (*Balaenoptera musculus*) may also occur, as other ceteceans.
Epipelagic (0-200 m)	**Seabirds**: foraging area for Cory's shearwaters (*Calonectris diomedea*) **Seaturtles:** Loggerhead turtle (*Caretta caretta*) have been found in the proximity of the MPA**;** Leatherback turtle (*Dermochelys coriacea*) may also occur
Management measures[240]	**Awareness raising** (*e.g.* incl. MPA in sea charts/maps; encourage vessels to comply with management measures); **Information building** (building/sharing and reporting information/knowledge (including scientific and technical) on biodiversity and ecosystems of this MPA and impacts of human activities taking place in this MPA; **Marine science**: promote application of "OSPAR Code of Conduct for responsible Marine Research in the deep seas and high seas of the OSPAR area" (OSPAR Agreement 2008-1) in this MPA; encourage, support and initiate scientific research projects/programmes to enhance knowledge base of the site, of the impacts from human activities, and of the solutions to achieve conservation objectives; encourage inclusion of this MPA as a reference area in scientific research programmes on climate change and the oceans; identify suitable mechanisms for monitoring the achievement of the MPA's conservation objectives; identify activities and mitigating actions to promote achievement of such conservation objectives. **New Developments**: divulge plans for human activities in this MPA, and for measures outside the area that may be potentially conflicting with the conservation objectives and likely to cause significant impact to the ecosystems of the MPA; ensure that, in such cases, an Environmental Impact Assessment (EIA) or Strategic Environmental Assessment (SEA) is carried out, and that appropriate measures are taken; engage stakeholders in planning new activities and assessing their potential impacts on this MPA; use best-available scientific advice when planning new activities and assessing their potential impacts on this MPA. **Third Parties**: engage with third parties (incl. relevant international organisations) to promote the delivery of the MPA's conservation objectives and to encourage application of the above programmes and measures.
Vulnerabilities (activities)	**Fishing:** fishing effort on the Milne cluster has not been quantified, but due to size and remote location, it may be little fished at present. As resources are depleted elsewhere, the MPA may be increasingly impacted by fishing activity. In deeper waters, conditions are more conducive to net loss. There is strong evidence of net dumping and significant levels of ghost shipping for deepwater shark and monkfish; **Bioprospecting**: potential future threat (however, there is no known info on bioprospecting in this MPA, and it seems more likely that in the near future this will occur around hydrothermal vent sites). **Mining**: (potential threat). No known information on the mineral composition of the Milne seamount.
BG opportunities	Science (not a direct BG field): the area may serve a reference site to study the effects of climate change. Tourism: ? Bioprospection: ? Mining: ? Transport: ?
Gaps/ uncertainties	Scientific knowledge of seamounts in general is poorer than for many other marine habitats, and there is little information about the Milne Seamount cluster specifically, which is rarely mentioned by name in scientific reports and for which little biological and ecological information is available. More research in this region is needed, namely regarding its: naturalness/pristineness; biological diversity; ecological communities. The Milne seamount area is likely to be similar to the topographical features in its surrounding area, namely the Sedlo seamount, in the Azorian EEZ (PT). Unnamed seamount SE of Milne not included in Ma because it is >3500 m and deemed to be not vulnerable to fishing pressure at present.

Table II.4. Altair Seamount MPA[241]

Designation	Altair Seamount MPA
Features	**Size:** 4408.71 km^2 **Biogeographic region:** warm-temperate Atlantic waters (44.32-44.86ºN; 33.54-34.46ºW) W of the Mid-Atlantic Ridge. Depth range 500 - >3500 m. Relatively isolated seamount, older than the seamounts found on the MAR, may potentially support more endemisms. Bottom is very hard, with steep topography, with few areas suitable for trawling MPA boundaries incorporate all areas that are at present and may in the future be accessible to fishing (sparse information on Altair justified application of the precautionary principle).
Benthic/ Demersal	Seamount and potentially cold-water coral and sponge reef habitats (qualify as VMEs in relation to high seas fisheries) and associated communities listed as examples of EBSAs according to the CBD.
Pelagic	**Fish**: A large and diverse fish fauna is expected to occur, including deep water sharks. Black scabbardfish (*Aphanopus carbo*) and Lantern shark (*Etmopterus princeps*) are known to occur in Altair MPA. The latter has been classified by ICES as vulnerable to fishing pressure due to its relatively long recovery time. **Cetaceans**: expected to occur
Epipelagic (0-200 m)	**Seabirds**: potentially Cory's shearwaters (*Calonectris diomedea*) **Seaturtles:** Loggerhead turtle (*Caretta caretta*) tracks suggest that Altair may be a hotspot for juveniles.
Management measures[242]	**Awareness raising** (*e.g.* incl. MPA in sea charts/maps; encourage vessels to comply with management measures); **Information building** (building/sharing and reporting information/knowledge (including scientific and technical) on biodiversity and ecosystems of this MPA and impacts of human activities taking place in this MPA; **Marine science**: promote application of "OSPAR Code of Conduct for responsible Marine Research in the deep seas and high seas of the OSPAR area" (OSPAR Agreement 2008-1) in this MPA; encourage, support and initiate scientific research projects/programmes to enhance knowledge base of the site, of the impacts from human activities, and of the solutions to achieve conservation objectives; encourage inclusion of this MPA as a reference area in scientific research programmes on climate change and the oceans; identify suitable mechanisms for monitoring the achievement of this MPA's conservation objectives; identify activities and mitigating actions to achieve such objectives. **New Developments**: divulge plans for human activities in this MPA, and for measures outside the area that may be potentially conflicting with the conservation objectives and likely to cause significant impact to the ecosystems of the MPA; ensure that, in such cases, an Environmental Impact Assessment (EIA) or Strategic Environmental Assessment (SEA) is carried out, and that appropriate measures are taken; engage stakeholders in planning new activities and assessing their potential impacts on this MPA; use best-available scientific advice when planning new activities and assessing their potential impacts on this MPA. **Third Parties**: engage with third parties (incl. relevant international organisations) to promote the delivery of the MPA's conservation objectives and to encourage application of the above programmes and measures.
Vulnerabilities (activities)	**Fishing:** evidence that fishing has occurred within the NEAFC fishery closure over Altair seamount; pressure may increase as shallower fish stocks are depleted. **Bioprospecting**: potential future threat (however, there is no known info on bioprospecting in this MPA, and it seems more likely that in the near future this will occur around hydrothermal vent sites). **Mining**: potential future threat. No information about mining within or near the MPA. In the future such exploitation in seamounts could expand. A possible threat could be mining of deeper cobalt crusts.
BG opportunities	Science (not a direct BG field): the area may serve a reference site (due to a potential high degree of naturalness still retained) to study the effects of climate change. Tourism: ? Bioprospection: ? Mining: ? Transport: ?
Gaps/ uncertainties	Few scientific studies have been conducted on Altair. There is no site-specific information about the biology (including biological diversity) and ecology of Altair seamount. Due to its characteristics (expected older age than seamounts on the MAR), it is possible, although unproven, that the biological community found on Altair has a greater abundance of endemics than the seamounts of the Mid-Atlantic Ridge. Lack of mapping effort in the area; little detailed knowledge of benthic structures within the MPA and their condition. Need for better mapping and better understanding of site's ecology.

Table II.5. Antialtair Seamount MPA[243]

Designation	Antialtair Seamount MPA
Features	**Size:** 2207.68 km^2 **Biogeographic region:** warm-temperate Atlantic waters (43.36-43.82ºN; 22.10-22.78ºW) located just NE of the Azores EEZ (PT), E of the MAR. Depth range 500 - >3500 m. Older than the seamounts found on the MAR, and may potentially support more endemisms. MPA boundaries incorporate and extend the NEAFC closure (precautionary principle justified by low levels of information).
Benthic/ Demersal	Seamount and potentially cold-water coral, coral gardens (non-scleratinian corals) and sponge reef habitats and associated communities (qualify as VMEs in relation to high seas fisheries) and associated communities listed as examples of EBSAs according to the CBD. Brachipod fauna not significantly different from other seamounts or nearby continental margin.
Pelagic	**Fish**: A large and diverse fish fauna is expected to occur, including deep water sharks. Orange roughy (*Hoplostethus atlanticus*) likely to be the summit-living sp. **Cetaceans**: expected to occur
Epipelagic (0-200 m)	**Seabirds**: potentially Cory's shearwaters (*Calonectris diomedea*)
Management measures[244]	**Awareness raising** (*e.g.* incl. MPA in sea charts/maps; encourage vessels to comply with management measures); **Information building** (building/sharing and reporting information/knowledge (including scientific and technical) on biodiversity and ecosystems of this MPA and impacts of human activities taking place in this MPA; **Marine science**: promote application of "OSPAR Code of Conduct for responsible Marine Research in the deep seas and high seas of the OSPAR area" (OSPAR Agreement 2008-1) in this MPA; encourage, support and initiate scientific research projects/programmes to enhance knowledge base of the site, impacts from human activities, and solutions to achieve conservation objectives; encourage inclusion of this MPA as reference area in scientific research programmes on CC and the oceans; identify suitable mechanisms for monitoring the achievement of this MPA's conservation objectives; identify activities and mitigating actions to achieve such objectives. **New Developments**: divulge plans for human activities in this MPA, and for measures outside the area that may be potentially conflicting with the conservation objectives and likely to cause significant impact to the ecosystems of the MPA; ensure that, in such cases, an Environmental Impact Assessment (EIA) or Strategic Environmental Assessment (SEA) is carried out, and that appropriate measures are taken; engage stakeholders in planning new activities and assessing their potential impacts on this MPA; use best-available scientific advice when planning new activities and assessing their potential impacts on this MPA. **Third Parties**: engage with third parties (incl. relevant international organisations) to promote the delivery of the MPA's conservation objectives and to encourage application of the above programmes and measures.
Vulnerabilities (activities)	**Fisheries:** There is evidence that fishing has occurred before and during/within the NEAFC fishery closure over Altair seamount, indicating that the area may already have been impacted by fishing and that fishing is a significant threat (despite the closure). **Bioprospecting**: potential future threat (however, there is no known info on bioprospecting in this MPA, and it seems more likely that in the near future this will occur around hydrothermal vent sites). **Mining**: potential future threat. No information about mining within or near the MPA. In the future such exploitation in seamounts could expand. A possible threat could be mining of deeper cobalt crusts.
BG opportunities	Science (not a direct BG field): the area may serve a reference site to study the effects of climate change, and the effects of fishing due to a potential high degree of naturalness still retained as compared to more heavily fished areas; Further study and monitoring should be developed to inform future decisions on the spatial protection of similar habitats. Tourism: ? Bioprospection: not likely Mining: Deeper cobalt crusts? Transport: -
Gaps/ uncertainties	Very little information is available about this seamount (including about the biological diversity of the seamount) and scientific exploration has been sporadic. There is no site-specific information available about the biology and ecology of Antialtair seamount. It is possible that the biological community found on Antialtair has more endemic species than the seamounts of the Mid-Atlantic Ridge, but research is needed to confirm this.

Table II.6. Josephine Seamount MPA[245]

Designation	Josephine Seamount MPA
Features	**Size:** 19,370 km^2 **Biogeographic region:** warm temperate waters of the Atlantic deep-sea subregion (36.18-37.63ºN; 13.42-15.72ºW) located to the E of the MAR, between the EEZ of continental Portugal and the Archipelago of Madeira. Represents the westernmost point of the Horseshoe seamount chain. Oval shaped with min. water depth of 170 m, and very steep S, SE and SW slopes down to 2000-3700 m.
Benthic/ Demersal	Invertebrate taxa reported from Josephine Seamount (150 spp. listed) include: Hexactinellid sponges, Hydrozoa, Scleractinia (14 spp.), antipatharians, gorgonians (12 spp.), Polychaeta, Bivalvia, Gastropoda, Cirripedia, Ostracoda, Halacarida, Picnogonida, Brachiopoda, Echinoidea, Ascidia. Reported endemics of the Josephine Seamount <3% total no. spp) include: *Victorgorgia josephinae* (Alcyonaria), *Genetyllis macrophthalma* (Polychaeta), *Propontocypris josephineae* (Ostracoda), *Arhodeoporus brevocularis* and *Atelopsalis newelli* (Halacarida). This is a low figure, which may not be accurate because of a gap in the knowledge of the two seamounts.
Pelagic	**Fish**: 31 spp. identified in the MPA. Likely occurrence of Orange roughy (*Hoplostethus atlanticus*) and other deep-sea fishes that under IUCN criteria qualify as critically endangered (thus requiring immediate protection); Blue shark (Prionace glauca) is a pelagic and highly migratory sp. and has been captured in the area of this MPA. Other shark spp. potentially occurring here are: Leafscale gulper shark (*Centrophorus squamosus*), Portuguese dogfish (*C. coelolepis*), Gulper shark (*C. granulosus*) and Porbeagle (Lamna nasus). The area where the MPA is located may be important habitat for the reproduction of *C. squamosus*, a commercially valuable and vulnerable spp. **Cetaceans**: potential occurrence of Sperm whale (*Physeter macrocephalus*) based on historical records.
Epipelagic (0-200 m)	**Sea turtles:** possible occurrence of Leatherback (*D. coriacea*) and Loggerhead (*C. caretta*)
Management measures[246]	**Awareness raising** (*e.g.* incl. MPA in sea charts/maps; encourage vessels to comply with management measures); **Information building** (building/sharing and reporting information/knowledge (including scientific and technical) on biodiversity and ecosystems of this MPA and impacts of human activities taking place in this MPA; **Marine science**: promote application of "OSPAR Code of Conduct for responsible Marine Research in the deep seas and high seas of the OSPAR area" (OSPAR Agreement 2008-1) in this MPA; encourage, support and initiate scientific research projects/programmes to enhance knowledge base of the site, impacts from human activities, and solutions to achieve conservation objectives; encourage inclusion of this MPA as reference area in scientific research programmes on CC and the oceans; identify suitable mechanisms for monitoring the achievement of this MPA's conservation objectives; identify activities and mitigating actions to achieve such objectives. **New Developments**: divulge plans for human activities in this MPA, and for measures outside the area that may be potentially conflicting with the conservation objectives and likely to cause significant impact to the ecosystems of the MPA; ensure that, in such cases, an Environmental Impact Assessment (EIA) or Strategic Environmental Assessment (SEA) is carried out, and that appropriate measures are taken; engage stakeholders in planning new activities and assessing their potential impacts on this MPA; use best-available scientific advice when planning new activities and assessing their potential impacts on this MPA. **Third Parties**: engage with third parties (incl. relevant international organisations) to promote the delivery of the MPA's conservation objectives and to encourage application of the above programmes and measures.
Vulnerabilities (activities)	**Fishing:** - Since 1977, Josephine Seamount has become one of just two fishable seamounts in the high seas, within the vicinity of Madeira, the Canary Islands and mainland Portugal; fishing has continued intermittently since then. - Given the ongoing fishing, affected spp. will likely take time to recover from past impacts. Shallow areas over the summits can be expected to recover more rapidly than deep areas. - Ongoing bottom fishing may result in damage to large suspension-feeders (*e.g.* hexactinellid sponges, gorgonians and black corals) - (Vulnerability to effects of hazardous materials transported from the Mediterranean by bottom currents. Such pollutants can enter the trophic chain). **Bioprospecting**: Extensive samples of large and small suspension-feeders (Porifera, Alcyonaria, Ascidia) with potential interest to bioprospectors. Their exploitation could seriously affect the vulnerable ecosystem of both seamounts in this area. **Mining**: unlikely to occur at the Josephine seamount as no valuable minerals have been reported and there is low potential for cobalt crust accumulation.
BG opportunities	**Science (not a direct BG field):** the area may serve a reference site to study the effects of climate change. Further study and monitoring should be developed to inform future decisions on the spatial protection of similar habitats. The Josephine Seamount can be regarded as an area of great scientific value and has been suggested (together with the horseshoe seamount) as unique science priority areas that should be protected for future generations. The long-term data set available for this seamount provides a unique opportunity for long-term monitoring of seamount ecosystems. Given its proximity to the continent, such monitoring would be easier to conduct than on a more remote seamount. **Tourism:** no known tourism activity occurs in the MPA. **Bioprospection:** Y **Mining:** N **Transport/Shipping:** (the area may be used by ships).
Gaps/ uncertainties	Lack of mapping effort in the area, leading to little detailed knowledge of benthic structures that exist within the MPA or their present condition. Gap in the knowledge of the two seamounts which may contribute to an underestimation in the number of existing spp.

Table II.7. Mid-Atlantic Ridge North of the Azores MPA[247]

Designation	Mid-Atlantic Ridge North of the Azores MPA
Features	**Size:** 93,568 km^2 **Biogeographic region:** warm temperate (sub-tropical) waters of the North Atlantic Province (43.30-44.70ºN; 24.80-32.30ºW) located S of the major biogeographic divide along the MAR (the CGFZ), and N of the Azores Archipelago and has the highest concentration of seamount features on the Mid-Atlantic Ridge. This section of the MAR N of the Azores is thought to have enhanced productivity in comparison to other open ocean areas, resulting from nutrient rich upwellings and eddies, particularly in the vicinity of seamounts (complex hydrographic setting and physical presence of the MAR). While the presence of seamounts was considered significant in justifying protection for a particularly vulnerable ecosystem, this MPA was designated as a representative section of the MAR habitat between the Azores and the CGFZ.
Benthic/ Demersal	Seamount habitats and cold water corals, potentially *Lophelia pertusa* reefs
Pelagic	**Fish**: Sword-fish (Xiphias gladius), Black scabbardfish (Aphanopus carbo), Orange roughy (Hoplostethus atlanticus). The most abundant spp. included *Coryphaenoides armatus* (Abyssal grenadier), *C. leptolepis* (Ghostly grenadier), *C. mediterraneus* (Mediterranean grenadier), *Halosauropsis macrochir* (Abyssal halosaur), *Rouleina attrita* (Softskin smooth-head) and *Synaphobranchus affinus* (Grey cutthroat). All are deep-water spp. with high-very high vulnerability to adverse impacts from exploitation based on their life-history traits. **Chondrichthyan fishes**: Blue shark (*Prionace glauca*); This MPA is the only part of the MAR in which *Centrophorus squamosus* and *Centroscymnus coelolepis* were recently caught, suggesting that it may be important as representative habitat in the OSPAR area. This area appears to be an important spawning area for Bigelow's Ray (Rajella bigelowi). **Cetaceans**
Epipelagic (0-200 m)	**Seabirds**: core foraging area for Cory's shearwater (*Calonectris diomedea*). The breeding pairs on the Azores make up >70% of the total breeding population of the Atlantic subspecies *C. diomedea borealis* (*i.e.*, a significant amount of this population relies on this area as foraging habitat). **Seaturtles:** Juveniles of loggerhead sea-turtle (*Caretta caretta*)
Management measures[248]	**Awareness raising** (*e.g.* incl. MPA in sea charts/maps; encourage vessels to comply with management measures); **Information building** (building/sharing and reporting information/knowledge (including scientific and technical) on biodiversity and ecosystems of this MPA and impacts of human activities taking place in this MPA; **Marine science**: promote application of "OSPAR Code of Conduct for responsible Marine Research in the deep seas and high seas of the OSPAR area" in this MPA; support scientific research projects/programmes to enhance knowledge base of the site, impacts from human activities, and solutions to achieve conservation objectives; encourage inclusion of this MPA as reference area in scientific research programmes on CC and the oceans; identify suitable mechanisms for monitoring the achievement of this MPA's conservation objectives; identify activities and mitigating actions to achieve such objectives. **New Developments**: divulge plans for human activities in this MPA, and for measures outside the area that may be potentially conflicting with the conservation objectives and likely to cause significant impact to the ecosystems of the MPA; ensure that, in such cases, an Environmental Impact Assessment (EIA) or Strategic Environmental Assessment (SEA) is carried out, and that appropriate measures are taken; engage stakeholders in planning new activities and assessing their potential impacts on this MPA; use best-available scientific advice when planning new activities and assessing their potential impacts on this MPA. **Third Parties**: engage with third parties (incl. relevant international organisations) to promote the delivery of the MPA's conservation objectives and to encourage application of the above programmes and measures.
Vulnerabilities (activities)	**Fisheries:** - Fishing with bottom gears has been conducted on the MAR and adjacent seamounts since at least 1973; Bottom trawling on the MAR in this area has been described as difficult (in more than 90% of tows the trawling gear had to be freed from the seabed). This indicates that the area is unlikely to have been subjected to intensive bottom trawling in the past. - At present, it is thought to be unlikely that major fisheries occur in the designated area - There is concern over Cory shearwater incidental mortality with longline fishing gear. **Bioprospecting**: No information (unlikely to occur). **Mining**: no information on the mining of minerals in the area. In the future seamounts may be targeted by mining operations for their cobalt crusts, although there is no information about the presence of such minerals in the MPA. **Tourism:** N (unlikely to emerge in the near future) **Scientific research:** impacts from this activity since 2003 (incl. trawling and other extractive methods) cover a very small area relative to the expanse of habitat. **Shipping:** N (unlikely to interfere with ship passage) **Cable laying**: No information available
BG opportunities	**Science (not a direct BG field):** the area may serve a reference site to study the effects of climate change. **Tourism:** no known tourism activity occurs in the MPA. **Bioprospection:** unlikely to occur **Mining:** unkown potential **Transport/Shipping:** (the area may be used by ships).
Gaps/ uncertainties	Data suggests the existence of a fundamental difference in production and biomass in this MPA compared to other parts of the MAR. More research required to verify this assumption. Insufficient data to make comparisons with other mid-ocean ridges or other areas such as isolated seamounts,

Designation	Mid-Atlantic Ridge North of the Azores MPA
	continental slopes and island slopes; little direct information about the sensitivity of habitats and species in this area Knowledge of mid-ocean ridges is sparse at best and many questions remain unanswered or partially answered. Ongoing monitoring and research is required. The vulnerability of the deep-sea to human impacts may mean that much of the diversity that is as yet unknown could be lost before we can catalogue it.

Annex III – EBSAs in the N Atlantic

Table III.1. Labrador Sea Deep Convection Area

Features	Key component of the global ocean circulation system (conveyor belt) The area is not fixed by geographic coordinates but delineated dynamically according to physical oceanographic properties. It is characterised by winter waters that almost always mix to depths > 200 m (in some years, to 1600 m).
Criteria (relevance)	**Explanation**
Uniqueness or rarity (High)	Unique oceanographic feature in the NW Atlantic: one of only three persistent areas in the world's oceans where intermediate-depth water masses are formed through the convective sinking of dense surface water. In the Labrador Sea this plays an important role in the exchange of heat, freshwater, dissolved gases (incl. CO_2 and O_2), and other substances between the atmosphere and the abyssal ocean, affecting water masses and circulation. As a crucial nexus in the global ocean thermohaline circulation, this area has a disproportionately large effect on downstream ecosystems, in comparison with its regional geographic spatial extent.
Special importance for life-history stages of species (Medium)	In this subpolar gyre, over-wintering pre-adult copepodite *Calanus finmarchicus* are dispersed over broad depth ranges (200 -2000 m) at relatively low concentrations, thus relatively safe from predation. This represents a vast reservoir for C. *finmarchicus*, which can repopulate adjacent shelves on an annual basis, and downstream regions (*e.g.*, Scotian Shelf, Gulf of Maine, Georges Bank) over longer time scales. Many other mesozooplankton species that undergo daily migration require the large vertical excursion afforded by the great depths of the central Labrador basin.
Importance for threatened, endangered or declining species and/or habitats (NI)	No available information.
Vulnerability, fragility, sensitivity, or slow recovery (Medium)	Seawater subject to increasing acidification (lower pH) from increasing concentration of dissolved inorganic carbon (rate of acidification in this area higher than global average rate). Species that require calcium carbonate to sustain life forms are sensitive to changes in pH and may be vulnerable to further seawater acidification. Weaker convection of oxygen-rich waters may exacerbate hypoxia in deeper layers downstream in the global thermohaline circulation.
Biological productivity (Low)	Phytoplankton biomass and primary production believed to be generally commensurate with other subpolar regions
Biological diversity (Low)	Phytoplankton and zooplankton diversities believed to be generally commensurate with other subpolar regions
Naturalness (Medium)	Effects of ocean warming and acidification may be evident here, as elsewhere.

Table III.2. Seabird Foraging Zone in the Southern Labrador Sea

Features	Located in the southern portion of the Labrador Sea, NE of Newfoundland in ABNJ. The seabirds using the area feed between 0-200 m. The specific areas used by each seabird species are likely to vary seasonally and inter-annually so the area defined by their joint occurrence will be dynamic in nature.
Criteria (relevance)	**Explanation**
Uniqueness or rarity (Medium)	The aggregation of birds from a large number of widely dispersed colonies (black-legged kittiwake, *Rissa tridactyla*) in the NE and NW Atlantic to a prescribed area during winter is rare, but occurs in the Labrador Sea.
Special importance for life-history stages of species (High)	Area constitutes an intersection of important foraging and wintering habitat for three seabird species from 20 breeding colonies in the NE and NW Atlantic: - critical wintering habitat for black-legged kittiwakes, *Rissa tridactyla* (c. 25% of the biogeographic population), with high degree of population mixing and overlap. - important wintering site for eastern Canadian populations of thick-billed murre, *Uria lombia* (c. 35% of the eastern Canadian population); - used by Leach's storm-petrels, *Oceanodroma leucorhoa*, from the world's largest colony while foraging during the incubation period.
Importance for threatened, endangered or declining species and/or habitats (Medium)	Regional concern for black-legged kittiwakes: declined in the NE Atlantic over the past couple of decades and appear on Red Lists of multiple countries. Populations tracked to the area represent c. 25% of the NE Atlantic population. Leach's storm-petrels in Newfoundland and Labrador declined substantially at a number of locally significant colonies in the last 15 years. The population tracked to the described area is c. 75% of E Canadian population.
Vulnerability, fragility, sensitivity, or slow recovery (Medium)	Seabirds are long lived (several decades) and slow reproducing, making them susceptible to negative impacts from threats such as accidental by-catch in gillnet, longline and trawl fisheries. The continental shelf region adjacent to this area has a history of heavy fisheries exploitation and could be a threat to seabird populations. Mortality caused by pollution from chronic and episodic oil spills, and collisions with lights and flares on offshore vessels and platforms can be problematic. Region situated mainly in pelagic areas, which includes the Orphan Basin, with ongoing oil and gas exploration and development.
Biological productivity (Medium)	Higher patches of primary productivity are seen in portions of the area during winter, but these were not consistent throughout the area or through time
Biological diversity (Medium)	Important habitat for three species of seabirds: thick-billed murre (multiple colonies in 5 tracked populations); black-legged kittiwake (14 of 18 populations); and Leach's storm-petrels.
Naturalness (Medium)	Being in the pelagic zone, there's likely a lower anthropogenic influence than in adjacent shelf areas. Fishing, however, has occurred over the continental shelf adjacent to the area for hundreds of years, and there are expanding oil exploration and extraction activities to the S and in the vicinity of the Grand Banks and Orphan Basin.
Additional relevant criteria (Medium)	The site qualifies as a Birdlife International Important Bird Area (IBA) for the black-legged kittiwake

Table III.3. Orphan Knoll

Features	An island of hard substratum and uniquely complex habitats that rise from the seafloor from the surrounding deep, soft sediments of Orphan Basin (a knoll is a mountain similar to a seamount, arising abruptly from the sea floor but less than 1000 m in height). Orphan Knoll is an irregularly shaped single peak reaching to 1800 m from the surface with one named seamount adjacent to the SE (Orphan Seamount). Boundaries were drawn to encompass both features.
Criteria (relevance)	**Explanation**
Uniqueness or rarity (High)	Orphan Knoll is a pocket of hard substratum amidst the soft sediments of Orphan Basin (the only knoll in the Orphan Basin). Although it is located near the continental slope, it is much deeper and has a distinctive fauna. A Taylor Cone[249] over the knoll promotes uniqueness and rarity through retention of eggs and larvae, creating potential for genetic isolation and distinct faunal assemblages
Special importance for life-history stages of species (No information)	No information available to evaluate this criterion. Mechanisms promoting endemism have been identified, and endemic species would require this area for completion of their life histories
Importance for threatened, endangered or declining species and/or habitats (No information)	No information available to fully evaluate this criterion. Scientific studies indicate that the summits and upper slopes of seamounts can provide refugia for cold-water stony corals from ocean acidification as they lie in shallower waters with a higher aragonite saturation horizon (increasing importance to life histories of cold-water corals in future).
Vulnerability, fragility, sensitivity, or slow recovery (High)	Cold-water corals and sponges have been observed on Orphan Knoll. Corals and sponges are known to be vulnerable, fragile and sensitive, exhibit slow recovery and growth rates, and are long-lived. To the extent these populations are found to be endemic, the oceanographic isolating mechanisms would also mean that re-colonization of populations on the Knoll from adjacent populations would be less likely, making both fish and invertebrate populations more vulnerable to local impacts.
Biological productivity (Low)	Little evidence that Orphan Knoll enhances the lower trophic level biology in the water column above the knoll.
Biological diversity (High)	High benthic diversity (info. based on limited observations) compared with the surrounding Orphan Basin.
Naturalness (High)	No evidence of demersal fishing on Orphan Knoll; oil and gas exploration localized and limited to one site.

Table III.4. Slopes of the Flemish Cap and Grand Banks

Features	The Flemish Cap is a plateau with a radius of c. 200 km at the 500 m isobath, <150 m deep at its centre. It is situated E of the Grand Banks of Newfoundland and separated from it by the c. 1200 m deep Flemish Pass. The area is delimited by 600 - 2500 m bathymetric contours and lies beyond the limit of the Canadian EEZ. The entire Beothuk Knoll is included (although its shallower depth is < 500 m).
Criteria (relevance)	Explanation
Uniqueness or rarity (High)	The only known area in international waters of the NW Atlantic where sponge grounds and sea pen concentrations have been identified. Recently, a sponge new to science has been described from the slope of Flemish Cap and Flemish Pass. Further sampling is required to determine if the species is restricted to the area.
Special importance for life-history stages of species (Medium)	Areas with high coral and sponge density are known to provide shelter and places for feeding and reproduction for other invertebrates and fish
Importance for threatened, endangered or declining species and/or habitats (High)	The described area is used by the northern bottlenose whale (*Hyperoodon ampullatus*), listed as endangered by Canada's Species at Risk Act (SARA). The northern and spotted wolffish (*Anarhichas denticulatus* and *A. minor*), both found in the area are threatened in the NW Atlantic. Protection of their habitat is one of the measures recommended to reverse their declining trend. Deep-sea sponge aggregations, sea pen communities and coral gardens are included on the OSPAR List of Threatened and/or Declining Species and Habitats.
Vulnerability, fragility, sensitivity, or slow recovery (High)	Deep-sea corals and large sponges are very vulnerable to perturbations, particularly to the mechanical impacts of bottom fishing activities (trawling), and can take decades or centuries to recover if they are removed.
Biological productivity (Medium)	Slopes make up a small proportion of the NW Atlantic reference zone but are particularly productive compared to shelves and plains. Neighbouring continental slopes off Newfoundland and Labrador were found to be highly productive (Canada identified several EBSAs encompassing these slopes within its EEZ). Many fish species are abundant within this area, which attracts many top predators, such as whales, pinnipeds, and seabirds.
Biological diversity (High)	The structural habitat created by sponge grounds and deep sea corals is known to increase the number and complexity of microhabitats, enhancing biodiversity. The area is diverse and productive compared with the abyssal plains surrounding it, but not more so than the neighbouring Grand Banks.
Naturalness (Medium)	Some of the areas, mainly on rough bottoms, including within canyons and below 1500 m depth, have likely been little fished or affected by any other human activity.

Table III.5. Southeast Shoal and Adjacent Areas on the Tail of the Grand Banks

Features	The area is defined by several distinct physical and geographical characteristics. The most significant is the SE Shoal, an ancient beach relic that provides a unique shallow (< 90 m) offshore sandy plateau. Bottom water temperatures on the shoal are amongst the warmest on the Grand Banks of Newfoundland. The area is located at the southern portion of the Grand Banks, south-east of Newfoundland (E of 51^{o}W and S of 45^{o}N). It extends from the 200nm (Canadian EEZ) to the 100 m contour. It is contiguous with an EBSA within the Canadian EEZ.
Criteria (relevance)	Explanation
Uniqueness or rarity (High)	The SE Shoal is the only shallow sandy offshore shoal on the Grand Banks, and has some of the warmest bottom water temperatures on the Grand Banks. The SE Shoal is the only known offshore spawning site for Capelin (*Mallotus villosus*). Being the last part of the Grand Banks to be deglaciated, unique relict populations of blue mussel and wedge clam (both typically found in inshore areas) and capelin (which normally spawn on beaches) remain in the SE Shoal area, associated with beach habitats from the last glacial advance.
Special importance for life-history stages of species (High)	SE Shoal contains foraging habitat for a large variety of cetaceans, including humpbacks (~15-30% of NW Atlantic population), which winter in the West Indies off Puerto Rico. Critical feeding grounds for seabirds breeding on Newfoundland colonies: - Key stop off point for common murre (*Uria aalge*) chicks departing the colony; - Primary N Atlantic feeding area for sooty (*Ardenna grisea*) and great shearwater (*Ardenna gravis*) during the nonbreeding season, when birds travel 15,000 km from the S Atlantic groups; - Primary wintering areas for auks from the Arctic and Newfoundland and Labrador regions. Offshore spawning capelin (*Mallotus villosus*) may be a genetically separate population; therefore the SE Shoal could be considered an exclusive spawning area that is vital to the fitness of the population. SE Shoal and adjacent area provides nursery habitat for yellowtail flounder (*Pleuronectes ferruginea*), American plaice (*Hippoglossoides platessoides*) and Atlantic cod (*Gadus morhua*). The SE Shoal contains the highest benthic biomass on the Grand Banks.
Importance for threatened, endangered or declining species and/or habitats (High)	Sooty shearwater (*Ardenna grisea*) listed as Near Threatened (IUCN Red List). Considered to be a habitat for baleen whales, such as fin whales, assessed as Endangered (IUCN Red List), and Special Concern (SARA). Habitat for striped wolffish (*Anarhichas lupus*), listed as special concern under the Canadian Species at Risk Act (SARA). Nursery ground for American plaice (*Hippoglossoides platessoides*), listed as threatened by COSEWIC (the stock is below reference points and under NAFO moratorium since 1994).
Vulnerability, fragility, sensitivity, or slow recovery (Medium)	A naturally dynamic environment, with open access to larger oceanic areas. Cetaceans, particularly large whales, such as blue and humpback whales, and seabirds are long-lived and slow to reproduce. The sandy bottom habitat that dominates this shallow shoal is subject to regular physical disturbance by wave action from storms, and so naturally dynamic and less sensitive to disturbance. However, the ecosystem and many of its components have been severely altered by fishing, which has altered community and ecosystem structure (*e.g.* both haddock and Atlantic cod, once abundant in this area, have been severely depleted by fishing and are therefore not fulfilling the same role in the ecosystem as they once did). A significant concentration of bryozoans (VME indicator species) is found on the Tail of the Grand Banks outside the SE Shoal feature, while a significant concentration of sea squirts (VME indicator species) is found on the shoal. Relict concentration of blue mussels on the shoal is also vulnerable to bottom fishing activities
Biological productivity (High)	Large spring phytoplankton bloom on the S Grand Banks, followed by summer blooms in zooplankton, both of which provide food for other species and the basis for a diverse ecosystem. The shallow sandy habitat (on the shoal of the bank) is a system of high biological productivity supporting many trophic levels, and including fish, seabirds and mammals.
Biological diversity (High)	High specific diversity, from phytoplankton to commercially important fish (*e.g.*, capelin, sand lance, cod, yellowtail founder, American plaice, skate), to cetaceans (*e.g.*, humpback, blue, fin, sei and minke whales, as well as long-finned pilot whales and beaked whales, harbor porpoise, Atlantic white-sided dolphins, and seabirds, as well as benthic species such as sea squirts and bryozoans. Several species and populations warrant special consideration due to their current status in relation to past abundance or as unique populations.
Naturalness (Low)	Fishing has been extensive in this area; the benthic species in the areas adjacent to the SE Shoal are vulnerable to bottom fishing
Additional relevant criteria (High)	The site qualifies as a Birdlife International Important Bird Area (IBA) for a number of the breeding and wintering species. SE Shoal has been described as a VME indicator element by NAFO based on the capelin spawning ground (NAFO Conservation and Enforcement Measures 2014). Significant concentrations of VME indicator species (bryozoans and sea squirts) are also found in the area.

Table III.6. New England and Corner Rise Seamount chains

Features	The New England – Corner Rise Seamount system is one of the longest seamount tracks in the Atlantic Ocean. This hotspot, referred to as the " New England hot spot", is > 3000 km long. A pause in volcanism 83 M y ago is responsible for the present day spatial gap between these two chains. Due to their common origin both seamount chains are herein considered together. Boundaries were drawn around the named seamounts in each of the New England and Corner Rise Seamount chains. The New England Seamounts feature extends into the EEZ of the USA but the area described here is entirely in ABNJ.
Criteria (relevance)	**Explanation**
Uniqueness or rarity (High)	The seamounts in this area are rare islands of hard substratum and uniquely complex habitats that rise into bathyal and epi-pelagic depths, and are otherwise surrounded by vast areas of abyssal sediments. Owing to their isolation, seamounts, tend to support endemic populations and unique faunal assemblages. Both seamount chains have numerous endemic species and demonstrate genetic isolation within and among seamount chains (one new genus from the New England Seamounts recently described). Within the area, the MacGregor seamount is unique in that it extends into the photic zone.
Special importance for life-history stages of species (High)	The canyons and seamounts provide virtually the only hard substrate habitat in the epi-pelagic and bathyal depths of the NW Atlantic for deep-water corals, sponges and other benthic species. These seamount chains provide a series of spatially structured features that form a broad corridor that may facilitate gene flow among populations of deep-sea and pelagic fauna, and provide nursery or feeding opportunities for migratory species. The summits and upper slopes of seamounts can provide refugia from ocean acidification for cold-water stony corals as they lie in shallower waters with a higher aragonite saturation horizon. This will have increasing importance to the life histories of cold-water corals in future.
Importance for threatened, endangered or declining species and/or habitats (No information)	No data presented to enable evaluation of this criterion.
Vulnerability, fragility, sensitivity, or slow recovery (Medium)	Fauna associated with seamounts are vulnerable to disturbance: orders of corals and sponge communities are known to be vulnerable, fragile, and sensitive, exhibit slow recovery and growth rates, and are long-lived; many fish species on seamounts aggregate and are locally restricted, and can be quickly depleted by fisheries. The Sargasso Sea Summary Report considered by COP 11 has also highlighted the high vulnerability of the Corner Rise and the New England Seamounts.
Biological productivity (No information)	No systematic assessment of the productivity of these areas
Biological diversity (High)	Very high benthic diversity on both seamount chains with numerous endemic and novel species of coral (> 270 benthic morphospecies have been observed from underwater camera surveys within this region)
Naturalness (Medium)	Some seamounts have been commercially fished but seamount slopes and deeper summit environments (> 2000 m) have not yet been directly impacted by human activities

Table III.7. Hydrothermal vent fields

Features	A group of 10 vent fields N of 23°N located between the Azores EEZ (PT) and above 14°N, including four sites with confirmed activity (Lost City, Broken Spur, TAG and Snake Pit), two sites where activity was inferred from the chemistry of plumes in the water column, and four inactive sites between 800-3900 m (the latter were considered since the characteristics that make them ecologically important (compared to the surrounding areas) remain (mineral deposits) and they support unique ecosystems).
Criteria (relevance)	**Explanation**
Uniqueness or rarity (High)	The hydrothermal vents associated with the area are regionally unique and globally rare. Venting produces unique chemical and mineral characteristics on the surrounding seabed, which are different from surrounding areas. There is a high level of endemism associated with the vents; some species are capable of chemosynthesis based on sulphur/sulphides released by the vents. The Lost City vent field is different from all other known sea-floor hydrothermal fields: it is located on 1.5-million-year-old crust and may be driven by the heat of exothermic reactions between sea water and peridotite. It is cool and alkaline relative to the other vent fields in this EBSA and wider area, and uniquely situated nearly 15 km from the spreading axis of the Mid-Atlantic Ridge. It is estimated to have been active > 30,000 years, exceeding the known longevity of black-smoker-type hydrothermal vents by two orders of magnitude
Special importance for life-history stages of species (High)	Chemosynthetic primary producers form the basis of the food web associated with hydrothermal vents. Associated fauna depend on the thermal and chemical properties of the water column associated with the vents.
Importance for threatened, endangered or declining species and/or habitats (No information)	The vents have yet to be examined with respect to the conservation status of individual species.
Vulnerability, fragility, sensitivity, or slow recovery (High)	Hydrothermal vents form relatively small structures and have communities that are highly localized and therefore vulnerable to disturbances on local scales. Damage to vent structures can lead to irreversible changes to the thermal and chemical properties of the surrounding water column. Given that vent ecosystems rely on vent fluids and gases for production, and that many taxa inhabit the structures formed by venting, any damage to the vent structures can lead to significant mortality through crushing, loss of available habitat, or loss of localized communities. The spatial structure and distinct community structure of fauna associated with vents may themselves be vulnerable to introduction of novel taxa (*e.g.*, during scientific surveys in multiple vent fields).
Biological productivity (High)	Active vents support dense populations of microbes, molluscs and tube worms. Dense swarms of shrimp are associated with chimneys at Trans-Atlantic Geotraverse (TAG) and Snake Pit. Microbial chemosynthetic production of organic carbon near the Broken Spur hydrothermal vent is considered to be very high for deep sea environments as it is comparable to primary production in the euphotic layer (in the absence of active venting, productivity would be significantly lower in local areas at similar depths and latitudes, as the food web structure and productivity depend on chemosynthesis).
Biological diversity (High)	As food web structure and productivity depend on chemosynthesis, in the absence of active venting, species diversity would be significantly lower in the localized vent fields.
Naturalness (High)	Some of the vent fields have been subject to scientific and other surveys subject to the ISA regulatory regime; however, compared to exploratory mining, such impacts are expected to be low.

Annex IV: NAFO VMEs

Table IV.1. Fogo Seamounts[250]

VME Name	Fogo Seamounts 1 and 2
Location	Fogo Seamounts 1 1. 42°31'33"N 53°23'17"W 2. 42°31'33"N 52°33'37"W 3. 41°55'48"N 53°23'17"W 4. 41°55'48"N 52°33'37"W Fogo Seamounts 2 1. 41°07'22"N 52°27'49"W 2. 41°07'22"N 51°38'10"W 3. 40°31'37"N 52°27'49"W 4. 40°31'37"N 51°38'10"W
Physical description	The Fogo Seamounts[251], are a group of seamounts located about 500 km offshore of Newfoundland and southwest of the Grand Banks of Newfoundland. This zone is narrowest in the NW and widens to 200 km in the SE. There are 7 named seamounts in this chain (many named after the ships that came to the aid of the Titanic) and they consist of basaltic submarine volcanoes that formed during the Early Cretaceous period. Bathymetric profiles across the larger seamounts show steep flanks and a relatively flatter top, 2 - 10 km across, although two of the seamounts do not have a flat top. Scoured moats or slope channels are found beside some of the seamounts and the seamounts are partially buried to the north and east by continental slope sedimentation. Frankfurt and Algerine Seamounts, in the Fogo Seamount Chain, were closed by NAFO. They are both greater than 2000 meters below sea level (mbsl). The Frankfurt Seamount is situated on the continental rise, and lies 93 miles NW of the Mount Temple Seamount and about 300 miles S of Cape Race, Newfoundland. The Algerine Seamount lies about 350 miles S of Cape Race, Newfoundland, in the NE portion of the Sohm Abyssal Plain.
General biology	The seamount crests are at a depth of 2000 to 4000 m below sea level (mbsl), with the adjacent ocean floor away from the continental slope at depths of 4500 to 5000 mbsl. There is no known biological sampling of the seamounts and they were closed by NAFO as VME elements that have a high probability of containing VMEs. Biological sampling on the Newfoundland Seamount Chain has identified xenophyophores, which are considered VME indicators.
VME Criteria	Seamounts
Manag. Body/Area type	(NAFO)Seamount closure
Begin/End date	31-12-2008/30-12-2020
Specific measures	Until 31 December 2020, no vessel shall engage in bottom fishing activities Period in force: 2017-01-01 to 2020-12-31, review in: 2020

Table IV.2. Orphan knoll[252]

VME Name	Orphan Knoll
Location	1. 50°00'30"N 45°00'30"W 2. 51°00'30"N 45°00'30"W 3. 51°00'30"N 47°00'30"W 4. 50°00'30"N 47°00'30"W
Physical description	Seamount (knoll): Single peak not shallower than 1800 m. Mid-depth waters above Orphan Knoll are in a boundary region between outflow from the Labrador Sea (subpolar gyre) and northward flow of the N Atlantic Current (subtropical gyre). Near-bottom current measurements show anti-cyclonic (clockwise) circulation around the knoll. W-E nutrient gradient, likely related to water mass differences between Orphan Basin and the region E of Orphan Knoll.
General biology	Orphan Basin-Orphan Knoll region is biologically rich and complex, and strongly influenced by local processes and advection. Coral (incl. stony coral) and sponges have been observed on the flanks while the flat bottomed top is muddy. Near-bottom anti-cyclonic circulation could have important implications for the benthic communities. The lower temperature over the seamounts in subpolar waters will likely contribute to slower recovery of ecosystems in these areas. In addition, environmental factors such as increasing ocean acidification will have a higher impact in the colder regions such as those in the subpolar gyre.
VME Criteria	Knoll
Manag. Body/Area type	NAFO Seamount closure
Begin/End date	31-12-2006 30-12-2020
Specific measures	Until 31 December 2020, no vessel shall engage in bottom fishing activities Period in force: 2017-01-01 to 2020-12-31, review in: 2020

Table IV.3. Corner Rise Seamounts[253]

VME Name	Corner Rise Seamounts
Location	1. 35°00'00"N 48°00'00"W 2. 36°00'00"N 48°00'00"W 3. 36°00'00"N 52°00'00"W 4. 35°00'00"N 52°00'00"W
Physical description	Seamounts: 19 peaks with some summits 800-900 m deep. The shallowest seamounts in the New England – Corner Rise Seamount system, rising from the sea floor to c. 1000 m depth or higher and cover c. 1270 km^2 in area from peaks above 2000 m depth. This hotspot, known as the "New England hotspot", is >3,000 km long. A pause in volcanism 83 million years ago is responsible for the present day spatial gap between these two seamount chains. (Some of these peaks fall outside of the NAFO convention area.)
General biology	Pristine coral areas documented in five of the Corner Rise Seamounts. Splendid alfonsino (*Beryx splendens*) is the most abundant deep-sea fish species found in these seamounts and appears to aggregate near certain seamounts. Other fish species include Cardinal fish (*Epigonus telescopus*), a slow growing and long-lived species. Kukenthal Peak and, more generally, the W portion of the Corner Rise are areas of high fish species diversity and abundance compared to other parts of the Corner Rise Seamounts. Other fish species include black scabbardfish (*Aphanopus carbo*), and wreckfish (*Polyprion americanus*).
VME Criteria	Seamount
Manag. Body/Area type	NAFO Seamount closure
Begin/End date	31-12-2006 30-12-2020
Specific measures	Until 31 December 2020, no vessel shall engage in bottom fishing activities Period in force: 2017-01-01 to 2020-12-31, review in: 2020

Table IV.4. Newfoundland Seamounts[254]

VME Name	Newfoundland Seamounts
Location (Outer limits)	1. 43°29'00"N 43°20'00"W 2. 44°00'00"N 43°20'00"W 3. 44°00'00"N 46°40'00"W 4. 43°29'00"N 46°40'00"W
Physical description	Seamounts: 6 peaks with summits all deeper than 2400 m, with most of the area being deeper than 3500m. The Newfoundland seamounts were volcanically active in the late Cretaceous period. Named seamounts include Shredder and Scruntion
General biology	Benthic imagery from the Newfoundland seamounts inside the NAFO closed area have identified xenophyophores, which are considered to be VME indicators.
VME Criteria	Seamount
Manag. Body/Area type	NAFO Seamount closure
Begin/End date	2007-01-01; until 2020-12-31
Specific measures	Until 31 December 2020, no vessel shall engage in bottom fishing activities Period in force: 2017-01-01 to 2020-12-31, review in: 2020

Table IV.5. New England Seamounts[255]

VME Name	New England Seamounts
Location (outer limits)	1. 39°00'00 N 64°00'00 W 2. 35°40'19 N 64°00'00 W 3. 35°40'08 N 63°57'22 W 4. 35°30'43 N 63°16'19 W 5. 35°15'29 N 62°37'55 W 6. 35°00'00 N 62°14'24 W 7. 35°00'00 N 57°00'00 W 8. 39°00'00 N 57°00'00 W
Physical description	Seamounts (17 peaks). The New England Seamounts are a 1200-km-long chain of about 30 volcanic peaks in the N Atlantic extending from Georges Bank within the US EEZ, to the E end of the Bermuda Rise, located in the New England – Corner Rise Seamount system. This hotspot, referred to as the "New England hotspot", is > 3000-km-long. A pause in volcanism 83 million years ago is responsible for the present day spatial gap between these two seamount chains.
General biology	Seamounts are uniquely complex habitats that rise into bathyal and epi-pelagic depths. Coral and other hard-bottom VME indicators have been documented on these seamounts.
VME Criteria	Seamount
Manag. Body/Area type	NAFO Seamount closure
Begin/End date	2007-01-01 until 2020-12-31
Specific measures	Until 31 December 2020, no vessel shall engage in bottom fishing activities Period in force: 2017-01-01 to 2020-12-31, review in: 2020

Table IV.6. 3O Coral Closure[256]

VME Name	3O Coral Closure
Location (outer limits)	1. 42° 53' 00" N 51° 00' 00" W 2. 42° 52' 04" N 51° 31' 44" W 3. 43° 24' 13" N 51° 58' 12" W 4. 43° 24' 20" N 51° 58' 18" W 5. 43° 39' 38" N 52° 13' 10" W 6. 43° 40' 59" N 52° 27' 52" W 7. 43° 56' 19" N 52° 39' 48" W 8. 44° 04' 53" N 52° 58' 12" W 9. 44° 18' 38" N 53° 06' 00" W 10. 44° 18' 36" N 53° 24' 07" W 11. 44° 49' 59" N 54° 30' 00" W 12. 44° 29' 55" N 54° 30' 00" W 13. 43° 26' 59" N 52° 55' 59" W 14. 42° 48' 00" N 51° 41' 06" W 15. 42° 33' 02" N 51° 00' 00" W
Physical description	The 3O closure occurs on the continental slope from 800m. The only closure in NAFO that straddles national and international waters. The area includes mostly soft bottoms with rocky outcrops.
General biology	There is no survey information for the portion of the 3O closure in the NAFO Regulatory area. The closure was made to protect coral VMEs. Sea pen and small gorgonian VMEs have been identified in the vicinity of the closure, while species distribution models indicate a high probability of sea pen presence in the closed area. VME elements are present: shelf-indenting canyons and canyons with heads > 400 m in depth in the closed area have potential to have VME.
VME Criteria	Seapens, Gorgonians, Cerianthids
Manag. Body/Area type	NAFO Coral closure
Begin/End date	31-12-2007 30-12-2020
Specific measures	Until 31 December 2020, no vessel shall engage in bottom fishing activities Period in force: 2017-01-01 to 2020-12-31, review in: 2020 Closed 2008-01-01 until 2020-12-31

Table IV.7. Tail of the Bank 1[257]

VME Name	Tail of the Bank
Location (outer limits)	1.1 44° 02' 53.88" N 48° 49' 9.48" W 1.2 44° 21' 31.32" N 48° 46' 48" W 1.3 44° 21' 34.56" N 48° 50' 32.64" W 1.4 44° 11' 48.12" N 48° 50' 32.64" W 1.5 44° 02' 54.6" N 48° 52' 52.32" W
Physical description	Canyon, shoal. A small closed area on the continental slope of the tail of Grand Bank straddling the fishing footprint around 2000 m in depth.
General biology	Closure originally established to protect sponge ground VME. Deep-sea sponge grounds are aggregations of large sponges that develop under certain geological, hydrological and biological conditions to form structural habitat. More recent studies to the S of this closure identified significant concentrations of erect bryozoans, large sea squirts (*Boltenia ovifera*) and small gorgonian VMEs, together with the presence of crinoids and cerianthids.[258]
VME Criteria	Sponge grounds, erect bryozoans, large sea squirts (*Boltenia ovifera*) and small gorgonian VMEs, together with the presence of crinoids and cerianthids.
Manag. Body/Area type	Area of higher sponge and coral concentration: Sponge, small gorgonian coral VMEs
Begin/End date	31-12-2009 30-12-2020
Specific measures	Until 31 December 2020, no vessel shall engage in bottom fishing activities Period in force: 2017-01-01 to 2020-12-31, review in: 2020 Closed since 2010-01-01 until 2020-12-31

Table IV.8. Flemish Pass/Eastern Canyon 2[259]

VME Name	Flemish Pass/Eastern Canyon 2
Location (outer limits)	2.1 44° 50′ 56.4″ N 48° 43′ 45.48″ W 2.2 46° 18′ 54.72″ N 46° 47′ 51.72″ W 2.3 46° 25′ 28.56″ N 46° 47′ 51.72″ W 2.4 46° 46′ 32.16″ N 46° 55′ 14.52″ W 2.5 47° 03′ 29.16″ N 46° 40′ 4.44″ W 2.6 47° 11′ 47.04″ N 46° 57′ 38.16″ W 2.7 46° 40′ 40.8″ N 47° 03′ 4.68″ W 2.8 46° 24′ 24.12″ N 46° 51′ 23.04″ W 2.9 46° 21′ 4.78″ N 46° 58′ 53″ W 2.10 46° 26′ 32″ N 46° 58′ 53″ W 2.11 46° 30′ 22.20″ N 47° 11′ 2.93″ W 2.12 46° 17′ 13.30″ N 47° 15′ 46.64″ W 2.13 46° 07′ 1.56″ N 47° 30′ 36.36″ W 2.14 45° 49′ 6.24″ N 47° 41′ 17.88″ W 2.15 45° 19′ 43.32″ N 48° 29′ 14.28″ W 2.16 44° 53′ 47.4″ N 48° 49′ 32.52″ W
Physical description	Canyon, shoal. E of the Grand Bank is the Flemish Cap, a plateau of approximately 200 km radius at the 500 m isobaths, with depths of < 150 m at its center and separated from Grand Bank by the approximately 1200 m deep Flemish Pass. This closed area includes the canyons on the E slope of Grand Bank, a portion of Flemish Pass in the S, and the W slope of the Flemish Cap. It straddles the 2000 m fishing footprint on the slopes except on Flemish Cap. The Flemish Pass contains sandy muds with accumulations of pebbles and stones apparently deposited by icebergs floating along this course. There is a complex hydrography in this area owing to the occurrence of two water masses. VME elements include canyons and shelf-indenting canyons.
General biology	This area was originally established to protect the extensive sponge ground VME in this area[260]. The dominant sponge species (in biomass) are demosponges of the order Astrophorida. Geodiids (mostly*Geodia barretti*), *Stelletta normani* and *Stryphnus ponderosus* occur in the deeper water. These are large-sized sponges, sometimes larger than 25 cm in diameter. These sponge grounds have been shown to house high species diversity compared with non-sponge ground habitat at similar depths. The area was subsequently expanded to include protection for large gorgonian corals in Flemish Pass. Some sponge, large gorgonians and seapen VMEs have been identified outside the closure.
VME criteria	Sponge and large gorgonians with sea pens in the northern part
Manag. Body/Area type	Area of higher sponge and coral concentration: Sponge, large gorgonians and sea pens VMEs
Begin/End date	31-12-2009 30-12-2020
Specific measures	Until 31 December 2020, no vessel shall engage in bottom fishing activities Period in force: 2017-01-01 to 2020-12-31, review in: 2020

Table IV.9. Beothuk Knoll 3[261]

VME Name	Beothuk Knoll 3
Location (Outer limits)	3.1 45° 49′ 10.2″ N 46° 06′ 2.52″ W 3.2 45° 59′ 47.4″ N 46° 06′ 2.52″ W 3.3 45° 59′ 47.4″ N 46° 18′ 8.28″ W 3.4 45° 49′ 10.2″ N 46° 18′ 8.28″ W
Physical description	Knoll. Beothuk Knoll is a discrete steep-sided plateau that forms an abrupt projection from the SW edge of Flemish Cap. The sediment drifts adjacent to Beothuk Knoll consist of sands. Beothuk Knoll has an iceberg turbate and there are isolated deep-water scours. Knolls are recognized as VME Elements.
General biology	The area was closed to protect sponge ground VME. Sponge and large gorgonian VMEs have been identified outside this closure.
VME Criteria	This area was protected for the large sponge concentrations found here.
Manag. Body/Area type	Area of higher sponge and coral concentration: Sponge VMEs
Begin/End date	31-12-2009 30-12-2020
Specific measures	Until 31 December 2020, no vessel shall engage in bottom fishing activities Period in force: 2017-01-01 to 2020-12-31, review in: 2020 Closed since 2010-01-01 until 2020-12-31;

Table IV.10. Beothuk Knoll 13[262]

VME Name	Beothuk Knoll 13
Location (Outer limits)	13.1 46° 13' 58.80" N 45° 41' 13.20" W 13.2 46° 13' 58.80" N 46° 02' 24.00" W 13.3 46° 21' 50.40" N 46° 02' 24.00" W 13.4 46° 21' 50.40" N 45° 56' 48.12" W 13.5 46° 20' 14.32" N 45° 55' 43.93" W 13.6 46° 20' 14.32" N 45° 41' 13.20" W
Physical description	Knoll. Physical VME elements include the Beothuk Knoll, steep flanks, and canyons with heads greater than 400 m.
General biology	Large sponges[263] and large gorgonian corals are known from this area.
VME Criteria	Large sponges[264] and large gorgonian corals; Knoll
Manag. Body/Area type	Area of high sponge and coral concentrations: Large sponges[265] and large gorgonian coral VMEs
Begin/End date	31-12-2014 30-12-2020
Specific measures	Until 31 December 2020, no vessel shall engage in bottom fishing activities Period in force: 2017-01-01 to 2020-12-31, review in: 2020 Closed since 2015-01-01until 2020-12-31

Table IV.11. Eastern Flemish Cap 4[266]

VME Name	Eastern Flemish Cap 4
Location (outer limits)	4.1 46° 44' 34.80" N 44° 03' 14.40" W 4.2 46° 58' 19.20" N 43° 34' 16.32" W 4.3 47° 10' 30.00" N 43° 34' 16.32" W 4.4 47° 10' 30.00" N 43° 20' 51.72" W 4.5 46° 48' 35.28" N 43° 20' 51.72" W 4.6 46° 39' 36.00" N 43° 58' 8.40" W
Physical description	Canyon, slope. Flemish Cap is a plateau of c. 200 km radius at the 500 m isobaths, being < 150 m deep at its center and separated from Grand Bank by the c. 1200 m deep Flemish Pass. The Flemish Cap has a patch of sand in its centre, in the shallower area, but most is covered with muddy sand and sandy mud. Bottom complexity increased along the S slope of the Flemish Cap by numerous submarine canyons and steep cliffs.
General biology	The area was closed to protect large gorgonian corals and sponge grounds[267]. Along the East of Flemish Cap high densities of the stalked crinoids *Gephyrocrinus grimaldii* occur together with several structure-forming sponges inside the closed area. Crinoids and cerianthids have also been found in this area. Sponge and large gorgonian VME have also been identified outside the closure.
VME Criteria	Sponges, large gorgonians, cerianthids
Manag. Body/Area type	Area of higher sponge and coral concentration: Sponges, large gorgonians, cerianthids VMEs
Begin/End date	31-12-2009 30-12-2020
Specific measures	Until 31 December 2020, no vessel shall engage in bottom fishing activities. Period in force: 2017-01-01 to 2020-12-31, review in: 2020

Table IV.12. NorthEast Flemish Cap 5[268]

VME Name	NorthEast Flemish Cap 5
Location (outer limits)	5.1 47° 47’ 46.00” N 43° 29’ 07.00” W 5.2 47° 40’ 54.47” N 43° 27’ 06.71” W 5.3 47° 35’ 57.48” N 43° 43’ 9.12” W 5.4 47° 51’ 14.4” N 43° 48’ 35.64” W 5.5 48° 27’ 19.44” N 44° 21’ 7.92” W 5.6 48° 41’ 37.32” N 43° 45’ 08.08” W 5.7 48° 37’ 13.00” N 43° 41’ 24.00” W 5.8 48° 30’ 15.00” N 43° 41’ 32.00” W 5.9 48° 25’ 08.00” N 43° 45’ 20.00” W 5.10 48° 24’ 29.00” N 43° 50’ 50.00” W 5.11 48° 14’ 20.00” N 43° 48’ 19.00” W 5.12 48° 09’ 53.00” N 43° 49’ 24.00” W
Physical description	Flemish Cap is a plateau of c. 200 km radius at the 500 m isobaths, with depths of less than 150 m at its center and separated from Grand Bank by the c. 1200 m deep Flemish Pass. The Flemish Cap has a patch of sand in its centre, in the shallower area, but most of the Cap is covered with muddy sand and sandy mud. The complexity of the bottom is increased along the southern slope of the Flemish Cap by numerous submarine canyons and steep cliffs. Steep flanks are the VME element in the closed area. The closed area straddles the NAFO fishing footprint with the deep extension outside.
General biology	This closure encompasses a vertical gradient of benthic communities[269], from coral dominated communities at ~2450 mbsl, to corals intermixed with sponges c. 2000 mbsl, to sponge dominated grounds at 1500 mbsl, and to a diverse community of corals, sponges and other benthic taxa at ~1300 mbsl.
VME Criteria	Sponge, crinoids, gorgonian corals
Manag. Body/Area type	Area of higher sponge and coral concentration: Sponge, crinoids, gorgonian corals VMEs
Begin/End date	31-12-2009 30-12-2020
Specific measures	Until 31 December 2020, no vessel shall engage in bottom fishing activities Period in force: 2017-01-01 to 2020-12-31, review in: 2020

Table IV.13. Sackville Spur 6[270]

VME Name	Sackville Spur 6
Location (outer limits)	6.1 48° 18’ 51.12” N 46° 37’ 13.44” W 6.2 48° 28’ 51.24” N 46° 08’ 33.72” W 6.3 48° 49’ 37.2” N 45° 27’ 20.52” W 6.4 48° 56’ 30.12” N 45° 08’ 59.99” W 6.5 49° 00’ 9.72” N 45° 12’ 44.64” W 6.6 48° 21’ 12.24” N 46° 39’ 11.16” W
Physical description	An elongate sediment drift feature that extends from the Grand Bank off Newfoundland across the N limit of the Flemish Pass and along the N slope of Flemish Cap in the NW Atlantic. The S flank of the Sackville Spur gently slopes toward the 900 m isobath in the Flemish Pass, while its steeper N flank extends to the floor of the Orphan Basin at 2500 m depth. The majority of the Sackville Spur experiences current speeds in excess of 0.20 m s^{-1}at the seabed as the waters exiting the Labrador Sea, particularly the Labrador Sea Water, flow E. The water either enters the Flemish Pass and flows S through to the Newfoundland Basin or continues further E along the Sackville Spur and either flows offshore or branches S along the eastern slope of Flemish Cap, to the Newfoundland Basin.
General biology	The area was closed to protect extensive sponge grounds. The dominant sponge species in biomass are demosponges of the order Astrophorida. Geodiids (mostly *Geodia barretti*), *Stelletta normani* and *Stryphnus ponderosus* occur in the deeper water. These large-sized sponges, sometimes reach > 25 cm in diameter. Vertical distribution of sponges between c. 1300 m - 1800 m. These sponge grounds host a high diversity and abundance[271,272] of associated megafaunal species.
VME Criteria	Sponge
Manag. Body/Area type	Area of higher sponge and coral concentration: Sponge VMEs
Begin/End date	31-12-2009 30-12-2020
Specific measures	Until 31 December 2020, no vessel shall engage in bottom fishing activities Period in force: 2017-01-01 to 2020-12-31, review in: 2020

Table IV.14. Northern Flemish Cap 7, 8, 9 [273,274,275]

VME Name	Northern Flemish Cap 7, 8, 9
Location (outer limits)	NFC7: 7.1 48° 25' 02.28" N 45° 17' 16.44" W 7.2 48° 25' 02.28" N 44° 54' 38.16" W 7.3 48° 19' 08.76" N 44° 54' 38.16" W 7.4 48° 19' 08.76" N 45° 01' 58.56" W 7.5 48° 20' 29.76" N 45° 01' 58.56" W 7.6 48°20' 29.76"N 45°17' 16.44" W NFC8: 8.1 48° 38' 07.95" N 45° 19' 31.92" W 8.2 48° 38' 07.95" N 45° 11' 44.36" W 8.3 48° 40' 9.84" N 45° 11' 44.88" W 8.4 48° 40' 9.84" N 45° 05' 35.52" W 8.5 48° 35' 56.4" N 45°05' 35.52" W 8.6 48° 35' 56.4" N 45°19' 31.92 W" NFC9: 9.1 48° 34' 23.52" N 45° 26' 18.96" W 9.2 48° 36' 55.08" N 45° 31' 15.96" W 9.3 48° 30' 18.36" N 45° 39' 42.48" W 9.4 48° 27' 30.6" N 45° 34' 40.44" W
Physical description	Flemish Cap is a plateau of c. 200 km radius at the 500 m isobaths, with depths < 150 m at its center and separated from Grand Bank by the c. 1200 m deep Flemish Pass. The Flemish Cap has a patch of sand in its centre, in the shallower area, but most of the Cap is covered with muddy sand and sandy mud.
General biology	Closure established to protect high concentration locations within one of the units of this seapen VME system[276,277]. Sea pens are key structural components of soft-bottom vulnerable marine ecosystems in the NRA. Aggregations of sea pens (sea pen fields), provide important structure in low-relief sand and mud habitats where there is little physical habitat complexity, and provide refuge for small planktonic and benthic invertebrates which in turn may be preyed upon by fish. A system of seapen VMEs has been identified extending around the edge of the Flemish Cap. These areas protect sea pens in unit 1. Crinoids and cerianthids, and black corals have been found associated with this seapen VME system. Sponge and seapen VME, cerianthids, and crinoids are also found outside the closure.
VME Criteria	Sea pens
Manag. Body/Area type	Area of higher sponge and coral concentration: Sea pen VMEs
Begin/End date	31-12-2009/30-12-2020
Specific measures	Until 31 December 2020, no vessel shall engage in bottom fishing activities. Period in force: 2017-01-01 to 2020-12-31, review in: 2020

Table IV.15. Northwest Flemish Cap 10, 11, 12[278], [279],[280]

VME Name	Northwest Flemish Cap 10, 11, 12
Location (outer limits)	NWFC10: 10.1 47° 49' 41.51" N 46° 22' 48.18" W 10.2 47° 47' 17.14" N 46° 17' 27.91" W 10.3 47° 58' 42.28" N 46° 6' 43.74" W 10.4 47° 59' 15.77" N 46° 7' 57.76" W 10.5 48°7' 48.97" N 45°59' 58.46" W 10.6 48°9' 34.66" N 46°4' 8.54" W NWFC11: 11.1 47° 25' 48" N 46° 21' 23.76" W 11.2 47° 30' 1.44" N 46° 21' 23.76" W 11.3 47° 30' 1.44" N 46° 27' 33.12" W 11.4 47° 25' 48" N 46° 27' 33.12" W NWFC12: 12.1 48°12' 6.60" N 45°54' 12.94" W 12.2 48°17' 11.82" N 45°47' 25.36" W 12.3 48°16' 7.06" N 45°45' 48.19" W 12.4 48° 11' 3.32" N 45°52' 40.63" W
Physical description	Flemish Cap is a plateau of c. 200 km radius at 500 m isobaths, being <150 m deep at its center and separated from Grand Bank by c. 1200 m deep Flemish Pass; Flemish Cap has a patch of sand in its centre, in the shallower area. Most of the Cap is covered with muddy sand and sandy mud.
General biology	Sea pens are key structural components of soft-bottom VMEs in the NRA. Aggregations of sea pens (sea pen fields) provide important structure in low-relief sand and mud habitats where there is little physical habitat complexity. These fields provide refuge for small planktonic and benthic invertebrates which in turn may be preyed upon by fish. A system of seapen VMEs has been identified extending around the edge of the Flemish Cap. Crinoids and cerianthids, and black corals have been found associated with this seapen VME system. Sponge and seapen VME, cerianthids, and crinoids are also found outside the closure. This closure was established to protect high concentration locations within one of the units (2) of this seapen VME system.
VME Criteria	Sea pens
Manag. Body/Area type	Area of higher sponge and coral concentration: Sea pen VMEs
Begin/End date	31-12-2009/30-12-2020; 31-12-2009/30-12-2020; 31-12-2013/30-12-2020;
Specific measures	NW FC 10: closed to bottom fishing until 31 Dec 2014 Period in force: 2013-01-01 to 2014-12-31 NW FC 11: Until 31 December 2020, no vessel shall engage in bottom fishing activities. Period in force: 2017-01-01 to 2020-12-31, review in: 2020 NWFP 12: Closed since 2014-01-01 until 2020-12-31 Until 31 December 2020, no vessel shall engage in bottom fishing activities. Period in force: 2017-01-01 to 2020-12-31, review in: 2020

Table IV.16. Eastern Flemish Cap 14[281]

VME Name	Eastern Flemish Cap 14
Location	14.1 47° 47' 54.33"N 44° 03' 06.46"W 14.2 47° 45' 24.44"N 44° 03' 06.46"W 14.3 47° 27' 34.89"N 43° 52' 00.35"W 14.4 47° 27' 34.89"N 43° 48' 18.54"W 14.5 47° 30' 04.80"N 43° 48' 18.54"W 14.6 47° 47' 54.33"N 43° 59' 23.40"W
Physical description	Flemish Cap is a plateau of c. 200 km radius at 500 m isobaths, being <150 m deep at its center and separated from Grand Bank by c. 1200 m deep Flemish Pass; Flemish Cap has a patch of sand in its centre, in the shallower area. Most of the Cap is covered with muddy sand and sandy mud.
General biology	The area was closed to protect sea pen VMEs from Unit 3.
VME Criteria	Sea pens
Manag. Body/Area type	Area of higher sponge and coral concentration: Sea pen VMEs
Begin/End date	31-12-2016/30-12-2018
Specific measures	Until 31 December 2018, no vessel shall engage in bottom fishing activities. Period in force: 2017-01-01 to 2018-12-31, review in: 2018

Annex V. NEAFC VMEs

Table V.1. Northern MAR Area

VME Name	Northern MAR Area
Location	1. 59.7500 -33.50000 59°45.00 -33°30.00 2. 57.5000 -27.50000 57°30.00 -27°30.00 3. 56.7500 -28.50000 56°45.00 -28°30.00 4. 59.2500 -34.50000 59°15.00 -34°30.00 5. 59.7500 -33.50000 59°45.00 -33°30.00
Physical description	Reykjanes Ridge south of Iceland EEZ. The Mid-Atlantic Ridge (MAR) between Iceland and the Azores may be characterised as one contiguous VME element with a complex topography, comprising the axial valley and flanks with hills and valleys of various depths and configurations and including many steep and seamount-like structures. Some major fracture zones occur where the ridge axis is broken and include deep east–west steep-walled canyon-like troughs. The major double fracture is the Charlie-Gibbs Fracture zone at about 52˚N.
General biology	Due to the structural complexity, mapping of individual VME elements has not been attempted. It is likely that most features shallower than 2000 m on the MAR are potential VME elements, but it should be noted that much of the area has a covering of sediment.
VME Criteria	VME Element: Steep-slopes and peaks on mid-ocean ridges; Protection of VME[282] (coldwater corals).
Manag. Body/Area type	Area closures for the protection of VMEs
Begin/End date	2009-2017
Specific measures	1) Area closed to bottom trawling and fishing with static gear, including bottom-set gillnets and longlines 2009–2017. 2) Deep-sea demersal fisheries regulations: Certain gears are banned (gillnets) and actions against ghost fishing and lost gear are in place. 4) Authorization to go to new fishing areas follows a strict exploratory fishing protocol.

Table V.2. Middle MAR Area

VME Name	Middle MAR Area (Charlie-Gibbs Fracture Zone and sub-Polar Frontal Region)
Location	1. 53.5000 -38.0000 53°30.00 -38°00.00 2. 53.5000 -36.8170 53°30.00 -36°49.00 3. 55.0760 -36.8170 55°04.53 -36°49.00 4. 54.9830 -34.6890 54°58.99 -34°41.36 5. 54.6860 -34.0000 54°41.18 -34°00.00 6. 53.5000 -34.0000 53°30.00 -34°00.00 7. 53.5000 -30.0000 53°30.00 -30°00.00 8. 51.5000 -28.0000 51°30.00 -28°00.00 9. 49.0000 -26.5000 49°00.00 -26°30.00 10. 49.0000 -30.5000 49°00.00 -30°30.00 11. 51.5000 -32.0000 51°30.00 -32°00.00 12. 51.5000 -38.0000 51°30.00 -38°00.00 13. 53.5000 -38.0000 53°30.00 -38°00.00
Physical description	Charlie-Gibbs Fracture Zone and sub-Polar Region. The Mid-Atlantic Ridge (MAR) between Iceland and the Azores may be characterised as one contiguous VME element with a complex topography, comprising the axial valley and flanks with hills and valleys of various depths and configurations and including many steep and seamount-like structures. Some major fracture zones occur where the ridge axis is broken and include deep east–west steep-walled canyon-like troughs. The major double fracture is the Charlie-Gibbs Fracture zone at about 52˚N.
General biology	Due to the structural complexity, mapping of individual VME elements has not been attempted. It is likely that most features shallower than 2000 m on the MAR are potential VME elements, but it should be noted that much of the area has a covering of sediment.
VME Criteria	VME Element: Steep-slopes and peaks on mid-ocean ridges; Protection of VME[283] (coldwater corals).
Manag. Body/Area type	Area closures for the protection of VMEs
Begin/End date	2009-2017
Specific measures	Area closed to bottom trawling and fishing with static gear, including bottom set gillnets and long-lines 2009-2017, including Charlie-Gibbs Fracture Zone and the Subpolar frontal zone.

Table V.3. Southern MAR Area

VME Name	Southern MAR Area
Location	1. 44.5000 -30.5000 44°30.00 -30°30.00 2. 44.5000 -27.0000 44°30.00 -27°00.00 3. 43.2500 -27.2500 43°15.00 -27°15.00 4. 43.2500 -31.0000 43°15.00 -31°00.00 5. 44.5000 -30.5000 44°30.00 -30°30.00
Physical description	The Mid-Atlantic Ridge (MAR) between Iceland and the Azores may be characterised as one contiguous VME element with a complex topography, comprising the axial valley and flanks with hills and valleys of various depths and configurations and including many steep and seamount-like structures. Some major fracture zones occur where the ridge axis is broken and include deep east–west steep-walled canyon-like troughs. The major double fracture is the Charlie-Gibbs Fracture zone at about 52˚N.
General biology	Due to the structural complexity, mapping of individual VME elements has not been attempted. It is likely that most features shallower than 2000 m on the MAR are potential VME elements, but it should be noted that much of the area has a covering of sediment.
VME Criteria	VME Element: Steep-slopes and peaks on mid-ocean ridges; Protection of VME284 (coldwater corals).
Area type	Area closures for the protection of VMEs
Begin/End date	2009-2017
Specific measures	1) Area closed to bottom trawling and fishing with static gear, including bottom-set gillnets and longlines 2009–2017. 2) Deep-sea demersal fisheries regulations: Certain gears are banned (gillnets) and actions against ghost fishing and lost gear are in place. 3) Authorization to go to new fishing areas follows a strict exploratory fishing protocol.

Table V.4. Altair Seamount

VME Name	Altair Seamount
Location	1. 45.0000 -34.5833 45°00.00 -34°35.00 2. 45.0000 -33.7500 45°00.00 -33°45.00 3. 44.4167 -33.7500 44°25.00 -33°45.00 4. 44.4167 -34.5833 44°25.00 -34°35.00 5. 45.0000 -34.5833 45°00.00 -34°35.00
Physical description	An isolated seamount lying to the west of the Mid-Atlantic ridge N of the Azores.
General biology	Altair Seamount is considered to be a potentially near-pristine example of an oceanic seamount ecosystem. Although little-explored, it is likely to contain unique species, as well as sustain important concentrations of a wide range of fish and corals.
VME Criteria	VME Element: Isolated seamounts
Area type	Area closures for the protection of VMEs
Begin/End date	2009-2017
Specific measures	These areas have been closed to bottom fishing since 2009. These closures will be reviewed in 2017.

Table V.5. Antialtair Seamount

VME Name	Antialtair Seamount
Location	1. 43.7500 -22.8333 43°45.00 -22°50.00 2. 43.7500 -22.0833 43°45.00 -22°05.00 3. 43.4167 -22.0833 43°25.00 -22°05.00 4. 43.4167 -22.8333 43°25.00 -22°50.00 5. 43.7500 -22.8333 43°45.00 -22°50.00
Physical description	Antialtair seamount is found in the North Atlantic just northeast of the Azores Exclusive Economic Zone. Antialtair is older than the seamounts of the Mid-Atlantic Ridge, which is still an active seafloor spreading centre.
General biology	Very little information is available about this seamount and as is common with many seamounts scientific exploration has been sporadic. Due to its age, it is possible that a greater number of endemic species will be present in comparison to Mid-Atlantic Ridge Seamounts.
VME Criteria	VME Element: Isolated seamounts
Area type	Area closures for the protection of VMEs
Begin/End date	2009-2017
Specific measures	These areas have been closed to bottom fishing since 2009. These closures will be reviewed in 2017.

Table V. 6. Hatton Bank

VME Name	Hatton Bank
Location	1. 59.4333 -14.5000 59°26.00 -14°30.00 2. 59.2000 -15.1333 59°12.00 -15°08.00 3. 58.5667 -16.7833 58°34.00 -16°47.00 4. 58.4833 -17.4167 58°29.00 -17°25.00 5. 58.5000 -17.8667 58°30.00 -17°52.00 6. 58.0500 -17.8667 58°03.00 -17°52.00 7. 58.0500 -17.5000 58°03.00 -17°30.00 8. 57.9167 -17.5000 57°55.00 -17°30.00 9. 57.7500 -19.2500 57°45.00 -19°15.00 10. 58.1858 -18.9585 58°11.15 -18°57.51 11. 58.1928 -19.1995 58°11.57 -19°11.97 12. 58.4625 -19.1942 58°27.75 -19°11.65 13. 58.6515 -19.2380 58°39.09 -19°14.28 14. 58.6352 -19.0215 58°38.11 -19°01.29 15. 58.8857 -18.7257 58°53.14 -18°43.54 16. 59.0048 -18.0218 59°00.29 -18°01.31 17. 59.1335 -17.8218 59°08.01 -17°49.31 18. 59.1458 -18.0245 59°08.75 -18°01.47 19. 59.2527 -18.0260 59°15.16 -18°01.56 20. 59.4028 -17.5203 59°24.17 -17°31.22 21. 59.3628 -17.2560 59°21.77 -17°15.36 22. 59.4485 -17.0277 59°26.91 -17°01.66 23. 59.7115 -16.7660 59°42.69 -16°45.96 24. 59.3495 -15.7458 59°20.97 -15°44.75 25. 59.3500 -15.6667 59°21.00 -15°40.00 26. 59.4333 -14.5000 59°26.00 -14°30.00
Physical description	Hatton Bank is a large volcanic bank, situated in the Atlantic North-West Approaches, towards the western extent of the UK Continental Shelf. It is an elongate, arc-shaped bank, stretching nearly 500km in length, and forming a submerged topographic high rising from the surrounding deep water. The water depth across the bank ranges from less than 500m on the northern part of the bank, to over 1000m at the base. At the south-eastern tip of the bank, an igneous complex called Lyonesse forms a topographic high, rising to 520m below sea level, some 350m shallower than the surrounding bank.
General biology	The hard substrata provided by the boulders, cobbles and bedrock reef at the site support a rich diversity of epifauna, including VME indicator species such as scleractinian corals, stylasterids ('lace' corals), antipatharians ('black' corals), soft corals, cup corals and gorgonian sea fans; a range of sponges, including glass sponges; and others such as sessile sea cucumbers; anemones and brachiopods. Also present are elaborate cold water coral reefs, frequently associated with topographically distinct features, including pinnacles and mounds tens of metres in height and hundreds of metres in width.
VME Criteria	VME Element: Knolls; Protection of VME[285] (coldwater corals and sponges).
Area type	Closures on the Hatton and Rockall Banks 2015
Begin/End date	2009-2017
Specific measures	Bottom trawling and fishing with static gear, including bottom set gillnets and long-lines is prohibited. The areas will be reviewed in 2017.

Table V.7. Rockall Bank

VME Name	Rockall Bank
Location	North West Rockall: 1. 57 -14.8833 57°00.00 -14°53.00 2. 57.6167 -14.7 57°37.00 -14°42.00 3. 57.9167 -14.4 57°55.00 -14°24.00 4. 58.25 -13.8333 58°15.00 -13°50.00 5. 57.95 -13.15 57°57.00 -13°09.00 6. 57.8333 -13.2333 57°50.00 -13°14.00 7. 57.95 -13.75 57°57.00 -13°45.00 8. 57.8167 -14.1 57°49.00 -14°06.00 9. 57.4833 -14.3167 57°29.00 -14°19.00 10. 57.3667 -14.3167 57°22.00 -14°19.00 11. 57 -14.5667 57°00.00 -14°34.00 12. 56.9333 -14.6 56°56.00 -14°36.00 13. 56.9333 -14.85 56°56.00 -14°51.00 14. 57 -14.8833 57°00.00 -14°53.00 South-West Rockall (Empress of Britain Bank): 1. 56.4 -15.6167 56°24.00 -15°37.00 2. 56.35 -14.9667 56°21.00 -14°58.00 3. 56.0667 -15.1667 56°04.00 -15°10.00 4. 55.85 -15.6167 55°51.00 -15°37.00 5. 56.1667 -15.8667 56°10.00 -15°52.00 6. 56.4 -15.6167 56°24.00 -15°37.00 Area 2: 1. 55.9483 -16.1883 55°56.90 -16°11.30 2. 55.97 -16.1883 55°58.20 -16°11.30 3. 55.9717 -16.0467 55°58.30 -16°02.80 4. 55.9483 -16.0467 55°56.90 -16°02.80 5. 55.9483 -16.1883 55°56.90 -16°11.30 Area 3: 1. 55.8317 -15.9333 55°49.90 -15°56.00 2. 55.8083 -15.9333 55°48.50 -15°56.00 3. 55.805 -15.8433 55°48.30 -15°50.60 4. 55.8267 -15.8433 55°49.60 -15°50.60 5. 55.8317 -15.9333 55°49.90 -15°56.00
Physical description	The Rockall Bank is situated approximately 300km west of the Hebridean island of St Kilda. It is a shallow bank situated beyond the continental shelf, and forming one of the western boundaries of the Rockall Trough. The Bank lies at depths ranging from 220m to 65m, though a small pinnacle of land – the island of Rockall – does actually break the sea surface toward the northern end of the Bank. The seabed of the Bank changes gradually, from low rock ridges and boulder fields covered in coarse sand to a virtually complete cover of fine sand.
General biology	The seabed of the Rockall Bank has been observed to be colonised by discrete patches of the ahermatypic coral *Lophelia pertusa*, which appears to be fairly common at depths ranging from 130 to 400m. Towed camera transects confirmed the presence of the coldseep habitat (bacterial mats, fluid vents) as well as coral gardens.
VME Criteria	VME Element: Steep flanks >6.4º (in part); Protection of VME[286] (coldwater corals and sponges).
Manag. Body/Area type	Closures on the Hatton and Rockall Banks 2015
Begin/End date	2009-2017
Specific measures	Bottom trawling and fishing with static gear, including bottom set gillnets and long-lines is prohibited. The areas will be reviewed in 2017.

Table V.8. Logachev Mounds

VME Name	Logachev Mounds
Location	1. 55.2833 -16.1667 55°17.00 -16°10.00 2. 55.5667 -15.1167 55°34.00 -15°07.00 3. 55.8333 -15.25 55°50.00 -15°15.00 4. 55.55 -16.2667 55°33.00 -16°16.00 5. 55.2833 -16.1667 55°17.00 -16°10.00
Physical description	The Logachev Mounds, on the southeast Rockall Bank, form a field of closely spaced, contiguous carbonate mounds. They are all found on the upper slope at depths between about 500 and 1200 m and about 500 have been mapped. They have a variety of shapes and the larger ones are very steep-sided, up to 350 m high and 2 km wide at the base. Sediment samples show that the mounds consist of pale coloured muds, mainly aragonite, usually with live and/or dead cold-water corals at the seafloor and with buried dead corals. Shelly sands are found on the seabed between the mounds.
General biology	Extensive occurrence of living deep-water coral reefs constructed principally by the reef-framework forming species, Lophelia pertusa and Madrepora oculata. Coral thickets appear to be detected from remote sensing as a brush-like signature on high resolution profiles and as a speckled pattern on high resolution sidescan sonar records.
VME Criteria	VME Element: Canyon-like features (in part); Protection of VME[287] (coldwater coral).
Manag. Body/Area type	Closures on the Hatton and Rockall Banks 2015
Begin/End date	2009-2017
Specific measures	Bottom trawling and fishing with static gear, including bottom set gillnets and long-lines is prohibited. The areas will be reviewed in 2017.

Table V.9. West Rockall Mounds

VME Name	West Rockall Mounds
Location	1. 57.3333 -16.5 57°20.00 -16°30.00 2. 57.0833 -15.9667 57°05.00 -15°58.00 3. 56.35 -17.2833 56°21.00 -17°17.00 4. 56.6667 -17.8333 56°40.00 -17°50.00 5. 57.3333 -16.5 57°20.00 -16°30.00
Physical description	The West Rockall Mounds are carbonate mounds.
General biology	Extensive occurrence of living deep-water coral reefs constructed principally by the reef-framework forming species, *Lophelia pertusa* and *Madrepora oculata*.
VME Criteria	Protection of VME[288] (coldwater coral)
Manag. Body/Area type	Closures on the Hatton and Rockall Banks 2015
Begin/End date	2009-2017
Specific measures	Bottom trawling and fishing with static gear, including bottom set gillnets and long-lines is prohibited. The areas will be reviewed in 2017.

Table V.10. Edora's Bank

VME Name	Edora's Bank
Location	1. 56.4333 -22.4333 56°26.00 -22°26.00 2. 56.4667 -22.0667 56°28.00 -22°04.00 3. 56.2667 -21.7 56°16.00 -21°42.00 4. 56.0833 -21.6667 56°05.00 -21°40.00 5. 55.9167 -21.7833 55°55.00 -21°47.00 6. 55.75 -22 55°45.00 -22°00.00 7. 55.7167 -23.2333 55°43.00 -23°14.00 8. 55.8333 -23.2667 55°50.00 -23°16.00 9. 56.0833 -23.1 56°05.00 -23°06.00 10. 56.3 -22.7167 56°18.00 -22°43.00 11. 56.4333 -22.4333 56°26.00 -22°26.00
Physical description	Edora Bank, SW of Hatton Bank. Edora's Bank as an area of unusually complex terrain and high rugosity. The bank has a distinct moat around the base clearly visible in the multibeam data, allowing its demarcation as geomorphologic feature.
General biology	Gorgonian corals[289], cup corals, soft corals, and coldwater reef building corals as well as sponges are recorded from the area.
VME Criteria	VME Element: Canyon-like features (in part); Protection of VME[290] (coldwater corals & sponges).
Manag. Body/Area type	Closures on the Hatton and Rockall Banks 2015
Begin/End date	2009-2017
Specific measures	Edora's Bank is not an existing NEAFC fishing area. This was closedby NEAFC Area 09 2013 - Bottom trawling and fishing with static gear, including bottom set gillnets and long-lines is prohibited. No end date was set in the text for this closure.

Table V.11. Southwest Rockall Bank

VME Name	Southwest Rockall Bank
Location	Area 1: 1. 55.9694 -16.2196 55°58.16 -16°13.18 2. 55.9706 -16.0427 55°58.24 -16°02.56 3. 55.9144 -16.0925 55°54.86 -16°05.55 4. 55.9694 -16.2196 55°58.16 -16°13.18 Area 2: 1. 55.9310 -15.6806 55°55.86 -15°40.84 2. 55.8500 -15.6167 55°51.00 -15°37.00 3. 55.7977 -15.8968 55°47.86 -15°53.81 4. 55.8215 -15.9399 55°49.29 -15°56.39 5. 55.9310 -15.6806 55°55.86 -15°40.84
Physical description	The Rockall Bank is situated approximately 300km west of the Hebridean island of St Kilda. It is a shallow bank situated beyond the continental shelf, and forming one of the western boundaries of the Rockall Trough. The Bank lies at depths ranging from 220m to 65m, though a small pinnacle of land – the island of Rockall – does actually break the sea surface toward the northern end of the Bank. The seabed of the Bank changes gradually, from low rock ridges and boulder fields covered in coarse sand to a virtually complete cover of fine sand.
General biology	VME indicators in the area include stony corals, sponges, sea pens, and the occasional black coral.
VME Criteria	Protection of VME[291] (coldwater coral)
Manag. Body/Area type	Closures on the Hatton and Rockall Banks 2015
Begin/End date	2009-2017
Specific measures	Bottom trawling and fishing with static gear, including bottom set gillnets and long-lines is prohibited. The areas will be reviewed in 2017.

Table V.12. Hatton-Rockall Basin

VME Name	Hatton–Rockall Basin
Location	Area 1: 1. 58.0025 -15.4538 58°00.15 -15°27.23 2. 58.0025 -15.6377 58°00.15 -15°38.26 3. 57.90317 -15.6377 57°54.19 -15°38.26 4. 57.90317 -15.4538 57°54.19 -15°27.23 5. 58.0025 -15.4538 58°00.15 -15°27.23 Area 2: 1. 58.1840 -16.5190 58°11.04 -16°31.14 2. 58.2166 -16.4205 58°13.00 -16°25.23 3. 58.1832 -16.3624 58°10.99 -16°21.74 4. 58.1348 -16.4511 58°08.09 -16°27.07 5. 58.1840 -16.5190 58°11.04 -16°31.14
Physical description	The Rockall Basin (also known as the Hatton Rockall Basin) is a large (c. 800 km by 150 km) sedimentary basin that lies to the west of Ireland and the United Kingdom beneath the major deepwater area known as the Rockall Trough. Water depth is over 1 km and the muddy sediments present support a range of species adapted to life at this depth.
General biology	The site is designated to protect unusual aggregations of deep-sea sponges – an OSPAR Threatened and/or Declining habitat. The MPA also includes protection for offshore deep-sea muds and a series of unique geological features known as polygonal faults. Polygonal faults are cracks in the seafloor, similar in appearance to those on a sun scorched desert.
VME Criteria	Protection of VME[292] (Sponges)
Manag. Body/Area type	Closures on the Hatton and Rockall Banks 2015
Begin/End date	2009-2017
Specific measures	Bottom trawling and fishing with static gear, including bottom set gillnets and long-lines is prohibited. The areas will be reviewed in 2017.

Table V.13. Hatton Bank 2

VME Name	Hatton Bank 2
Location	Area 1: 1, 57.8626 -18.0978 57°51.76 -18°05.87 2. 57.9167 -17.5000 57°55.00 -17°30.00 3. 58.0500 -17.5000 58°03.00 -17°30.00 4. 57.8850 -16.9388 57°53.10 -16°56.33 5. 57.5851 -18.0335 57°35.11 -18°02.01 6. 57.8626 -18.0978 57°51.76 -18°05.87 Area 2: 1. 57.9993 -19.0842 57°59.96 -19°05.05 2. 57.7500 -19.2500 57°45.00 -19°15.00 3. 57.8345 -18.3970 57°50.07 -18°23.82 4. 57.5188 -18.3547 57°31.13 -18°21.28 5. 57.2348 -19.4738 57°14.09 -19°28.43 6. 57.0368 -19.4588 57°02.21 -19°27.53 7. 56.8853 -19.4828 56°53.12 -19°28.97 8. 56.8370 -19.5604 56°50.22 -19°33.62 9. 56.7780 -19.8954 56°46.68 -19°53.72 10. 57.0007 -20.0704 57°00.04 -20°04.22 11. 57.1718 -19.9207 57°10.31 -19°55.24 12. 57.5445 -19.8773 57°32.67 -19°52.64 13. 57.7780 -19.6310 57°46.68 -19°37.86 14. 57.9993 -19.0842 57°59.96 -19°05.05
Physical description	A sedimentary seabed that covers much of the SW slopes of the Hatton Bank (Hatton Drift) mainly composed by muddy-sandy deposits.
General biology	Area 1: Deep-sea sponges and gorgonians Area 2: Stony coral, gorgonians, sea pens, knoll area, carbonate mounds and out-cropped rock
VME Criteria	Protection of VME[293] (coldwater coral and sponge)
Manag. Body/Area type	Closures on the Hatton and Rockall Banks 2015
Begin/End date	2009-2017
Specific measures	Bottom trawling and fishing with static gear, including bottom set gillnets and long-lines is prohibited. The areas will be reviewed in 2017.

Annex VI. Expected effects of climate change on the main ecological components of N Atlantic ABMTs

Table VI.1. Expected effects of climate change on the main ecological components of OSPAR high seas MPAs

Areas	Depth	Taxa	Parameter	Climate Change Impact	1st Impacts
Charlie-Gibbs North; Charlie-Gibbs South	?->3,500 m	Cold water corals (770-2360m), sponges; Zooplankton (*C. finmarchichus*) Deepwater fish (incl. Sharks) Cetaceans	Dec. pH	Corals: Shallowing of ASH; erosion of dead corals; higher metabolic stress for live corals; Variable effects on sponges (positive and negative) Zooplankton: reduced production Fish: red. ability settle & avoid predat. Mammals: diff. prey availab./ abund.	Before 2050
			Red. O2	Corals: habitat reduction and mortality Zoopl.: potential change in spp. distrib. Fish: Habitat compression into shallower depths Cetaceans: change in vital rates dependent on prey availability	
			Inc. Temp.	Corals: chang. vital rates & in distrib. Zoopl.: increas. metabolism; red. condit. Sharks: Shift in distrib. or deeper depths; Cetaceans: shift in distribution	
			Red. POC flux	Corals: Decr. prod.; Shifts in distribution Zoop.: follows changes in Prim. Product. Fish: change in vertical position of pelagic fish and larvae Mammals: reduced feeding opport.	
			Red. AMOC	Corals: ? Zooplankton: introd. warm water spp. Fish, mammals: Affects distribution/ range of some spp., prey availability	
Milne Seamount complex		Cold water corals, sponges Deepwater fish (incl. Sharks) Cetaceans Birds, turtles	Dec. pH	Corals: Shallowing of ASH; erosion dead corals; higher metab. stress live corals Sponges: Variable effects Fish: reduced habitat Birds, mammals, turtles: changes dependent on prey response	
			Red. O2	Corals: habitat reduction and mortality Fish: Hab. compr. into shallower depths Fish, Birds, mammals, turtles: changes dependent on prey response	
			Inc. Temp.	Corals: changes in viral rates; shifts in distribution Fish: Shift in distrib. or deeper depths; Cetaceans, birds: shift in distribution; thermoreg. stress Turtles: changes in distrib. & vital rates	
			Red. POC flux	Decreased productivity Corals: Shifts in distribution Fish: change in vertical position of pelagic fish and larvae Mammals: red. feeding opportunities Birds, turtles: changes in vital rates dependent on prey availability	
			Red. AMOC	Corals: ? Other groups: Affects distribution/range of some spp., prey availability	
Altair Seamount		Potential cold water corals, sponges, diverse fish fauna Hotspot *C. caretta*	Dec. pH	Corals: Decr. calc. and food availability; Change in reproduction; Fish: red. ability to settle on coral reefs and avoid predators Turtles: changes depend prey response	
			Red. O2	Corals: habitat reduction and mortality Fish: Hab. compression to shallow. depths Fish, turtles: changes dependent on prey response	
			Inc. Temp.	Corals/Sponges: changes in vital rates, shifts in distribution Fish: latitudinal and depth adaptations; Turtles: change in vital rates dependent on prey response	

Areas	Depth	Taxa	Parameter	Climate Change Impact	1st Impacts
			Red. POC flux	Corals/Sponges: Decreased productivity Other groups: Changes in trophic interactions/ prey availability	
			Red. AMOC	Sponges/Corals: ? Fish, turtles: change in migration	
Antialtair Seamount		Coral garden, sponges, fish	Dec. pH	Corals/Sponges: Decr. in calcification rates and in food availability; Change in reproduction; Fish: red. ability to settle & avoid predat.	
			Red. O2	Corals/Sponges: Habitat reduction/mortality Fish: Habitat compres. to shallow. depths	
			Inc. Temp.	Corals/Sponges: changes in vital rates, shifts in distribution Fish: latitudinal and depth adaptations;	
			Red. POC flux	Corals/Sponges: Decreased productivity	
			Red. AMOC	Sponges/Corals: ? Fish: change in migration	
MARNA		Seamount; cold water corals, sponges, fish, birds	Dec. pH	Corals/Sponges: Dec. in calcification rates; Change in reproduction; Decrease in food availability Fish: red. ability to settle and avoid pred. Birds: changes in prey availability	
			Red. O2	Corals/Sponges: Habitat reduction/mortality Fish: Habitat compression into shallower depths Birds: change in vital rates	
			Inc. Temp.	Corals/Sponges: changes in vital rates, shifts in distribution Fish: latitudinal and depth adaptations; Birds: changes in distribution, migratory timing and routes	
			Red. POC flux	Corals/Sponges: Decreased productivity	
			Red. AMOC	Sponges/Corals: ? Fish: change in migration Birds: changes dependent on prey availability	
Josephine Seamount		Cold water corals, fish	Dec. pH	Corals: Decr. calc.; Change in reproduction; Decr. food availability Fish: red. ability to settle & avoid pred.	
			Red. O2	Corals: Habitat reduction/mortality Fish: Hab. compr. into shallower depths	
			Inc. Temp.	Corals: changes in vital rates, shifts in distrib. Fish: latitudinal & depth adaptations;	
			Red. POC flux	Corals: Decreased productivity	
			Red. AMOC	Sponges: ? Fish: change in migration	
Evlanov Seamount and basin MPA proposal	0->4,000 m	Zooplankton, fish, cephalopods, mammals, birds, turtles	Dec. pH	Zoopl.: Reduced production of calcifying organisms; possible extinction Fish: less food/refugia Mammals: changes in prey availability and abundance Turtles, birds: Change in vital rates dependent on prey availability/ response	
			Red. O2	Zoopl.: Spp. distributions may change; Jellyfish may become more prevalent Fish: Decrease in habitat, reduced growth and thermal tolerance; Fish, Mammals, turtles, birds: Change in vital rates dependent on prey availab.	
			Inc. Temp.	Zooplankton: Increases in metabolism, growth and development and in jellyfish abundance; reduced condition Fish: deeper shift in distribution; Change in vital rates Mammals, birds, turtles: Change in vital rates dependent on prey response; Thermoregulation issues	
			Red. POC flux	Decreased productivity	
			Red. AMOC	Zooplankton: Introduction of warm water spp. to N ecosystems Fish: Changes in migration, warm water spp. to northern ecosystems Mammals, birds, turtles: Change in vital rates and distribution dependent on prey availability	

Table VI.2. Expected effects of climate change on the main ecological components of EBSAs

Area	Depth*	Species affected	Parameter	Climate Change Impact	Time Frame 1st Impacts
Labrador Deep Sea Convection Area	0-200 or >1,600m	*Calanus finmarchichus*	Dec. pH	Reduced production	
			Red. O2	Change in species distribution	
			Inc. Temp.	Increas. jellyfish abundance; increases in metabolism; reduced condition due to trophic effects	
			Red. POC flux	Decreased productivity	
			Red. AMOC	Introduction of warm water sp.	
Seabird foraging Zone in S Labrador Sea	0-200m	Seabirds	Dec. pH	Change in vital rates dependent on prey response	-
			Red. O2	Change in vital rates dependent on prey availability	
			Inc. Temp.	Change in migratory timing, routes and in distribution; Indirect effects of invasive species; thermoregulatory stress	
			Red. POC flux	Changes in prey availability	
			Red. AMOC	Shift in distribution and change in vital rates dependent on prey availability	
Orphan Knoll	Peaks at 1,800 m deep, < 1,000 m in height, Taylor cone above	Corals, sponges Benthic diversity	Dec. pH	Shallowing of ASH erosion of dead corals; higher metabolic stress for live corals Variable effects on sponges (positive and negative) Benthos: lower growth and decrease in shell length of benthic calcifiers	
			Red. O2	Corals: habitat reduction and mortality of deeper corals Benthos: increased mortality; change in species composition and distribution	
			Inc. Temp.	Corals: descrease in calcification leading to mortality; changes in vital rates; shifts in distribution Benthos: N shift in distribution and shifts to deeper depths; changes in vital rates, mortality in sessile species; increased disease	
			Red. POC flux	Reduced food availability	
			Red. AMOC	Corals: ? Benthos: introduction of warm water species	
Slopes of the Flemish Cap	600-2,500m	Unique sponge and sea pen grounds N and spotted wolffish Whale (*Hyperoodon ampullatus*)	Dec. pH	Corals: Decreases in calcific. rates and in food availability; Change in reproduction; Fish: reduced ability to settle and avoid predators Mammals: changes in prey availability and abundance	
			Red. O2	Corals: habitat red. & mortality Fish: Habitat decrease/ compression into shallower depths; reduced growth and thermal tolerance Fish, mammals: changes in vital rates depend. on prey response	
			Inc. Temp.	Corals/Sponges: Decrease in calcification, often leading to mortality; changes in vital rates, shifts in distribution Fish: latitude. and depth adaptations; shifts in vital rates Whale: change in vital rates depend. prey response; thermoregulation issues	
			Red. POC flux	Corals/Sponges: Decreased productivity Fish and mammals: changes in vital rates dependent on prey response;	
			Red. AMOC	Sponges/Corals: ? Fish: changes in migration; introduction of warm water species to northern ecosystems Mammals: Changes in vital rates dependent on prey availability	
SE Shoal and Adjacent	(c. 90 m deep)	Phyto/zoop.. Highest	Dec. pH	Phyto and zooplankton: reduced production of calcifying organisms;	

Area	Depth*	Species affected	Parameter	Climate Change Impact	Time Frame 1st Impacts
areas on the Tail of the Grand Banks		benthic biomass; Relict populations mussels/ clams Unique capelin spawning grounds; fish nursery; Birds: Feeding/winter. area Whales		Benthic calcifiers: lower growth and decrease in shell length Corals/Sponges: Decr. calc. rates and food availab.; Change reprod.; Fish: reduced ability to settle and avoid predators Birds: change in vital rates dependent on prey response Mammals: changes in prey availability and abundance	
			Red. O2	Phytoplankton: No effect Zoopl.: Spp. distributions may change; jellyfish more preval. Benthos: increase in mortality; change in spp. composition and dist. Corals/Sponges: Habitat reduction/mortality Fish: Decrease in habitat, reduced growth and thermal tolerance; Fish, birds, mammals: change in vital rates depend. on prey availab,	
			Inc. Temp.	Phytop.: smaller average size; changes in vital rates; Zoop.: incr. metabolism, growth and development and jellyfish abundance; trophic effects lead to reduced condition Benthos: N/ deeper shift in distrib.; mass mortality events in sessile spp.; change in vital rates; increased disease Corals/Sponges: changes in vital rates, shifts in distribution. Decr. calc. leading to mortality Fish: latitudinal & depth adapt.; changes in vital rates Birds: change in migratory timing, routes, and distrib.; indirect effects of invasive spp.; thermoregulatory stress Mammals: changes in vital rates dependent on prey response; thermoreg. issues	
			Red. POC flux	Phyto/zooplankton, benthos, Corals/Sponges: Decreased productivity Fish, birds, and mammals: changes in vital rates dependent on prey response;	
			Red. AMOC	Phyto/Zooplankton, benthos: introduction warm water spp. Sponges/Corals: ? Fish: change in migration, introd. of warm water spp Birds: Shift in distribution Birds, mammals: change in vital rates dependent on prey availability	
New England and Corner Rise Seamount Chains	? (some areas > 2000m)	Very high benthic diversity (inc. endemic/novel corals) Fish	Dec. pH	Benthos: lower growth and decrease in shell length (benthic calcifiers) Corals: Decreases in calcification rates; Change in reproduction; Decrease in food availability Fish: reduced ability to settle and avoid predators	
			Red. O2	Benthos: change in species composition and distribution; increased mortality Corals/Sponges: Habitat reduction/mortality Fish: Habitat compression into shallower depths; change in vital rates dependent on prey availability	
			Inc. Temp.	Benthos: N shift in distrib.; mass mortality events in sessile spp.; shifts to deeper depths; change in vital rates; increased disease Corals/Sponges: decrease in calcification leading to mortality; changes in vital rates, shifts in distribution Fish: latitudinal and depth adaptations; change in vital rates	
			Red. POC flux	benthos, Corals/Sponges: Decreased productivity	

Area	Depth*	Species affected	Parameter	Climate Change Impact	Time Frame 1st Impacts
				Fish: changes in vital rates dependent on prey response;	
			Red. AMOC	Benthos: introd. warm water spp. Sponges/Corals: ? Fish: change in migration, introduction of warm water spp	
Hydrother. vent fields		Chemosynth. prod.; vent communities	Dec. pH	No effect	
			Red. O2	No effect	
			Ind. Temp.	No effect	
			Red. POC flux	No effect	
			Red. AMOC	No effect	

Table VI.3. Expected effects of climate change on the main elements of NAFO VMEs

Area	Depth*	Taxa	Parameter	Climate Change Impact	1st Impacts
Fogo Seamounts	Crests: 2,000-4,000m Ocean floor 4,500-5,000m	Xenophyophores	Dec. pH	?	
			Red. O2	?	
			Inc. Temp.	?	
			Red. POC flux	?	
			Red. AMOC	?	
Orphan Knoll	Deeper than 1,800m	Corals (incl. Stony coral) and sponges	Dec. pH	Decr. calc. rates and food availab.; Change in reprod.;	
			Red. O2	Habitat reduction/mortality	
			Inc. Temp.	Change vital rates, shifts distrib. Decr. calc. leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
Corner Rise Seamounts	Summits 800-900 m deep	Pristine corals Diverse fish, including: splendid alfonsino, cardinal fish, black scabbarfish, wreckfish	Dec. pH	Corals: Decr. calcification rates & food availability; Change in reproduction; Fish: reduced ability to settle and avoid predators	
			Red. O2	Corals: Habitat reduction/mortality Fish: Decrease in habitat, red. growth & thermal tolerance; change in vital rates dep. prey availability	
			Inc. Temp.	Corals: changes in vital rates, shifts in distribution. Decrease in calcification often leading to mortality Fish: latitudinal & depth adapt.; changes in vital rates	
			Red. POC flux	Corals: Decreased productivity Fish: changes in vital rates dependent on prey response;	
			Red. AMOC	Corals: ? Fish: change in migration, introd. of warm water spp	
Newfound. seamounts	Summits > 2,400m Most of the area > 3,500 m	Xenophyophores	Dec. pH	?	
			Red. O2	?	
			Inc. Temp.	?	
			Red. POC flux	?	
			Red. AMOC	?	
New England Seamounts	?	Corals and other hard-bottom VME indicators	Dec. pH	Decr. calc. rates and food availab.; Change in reprod.;	
			Red. O2	Habitat reduction/mortality	
			Ind. Temp.	Change vital rates, shifts distrib. Decr. calc. leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
3O Coral closure	Cont. Slope from 800 m	Seapens, Gorgonians, Cerianthids	Dec. pH	Decr. calc. rates and food availab.; Change in reprod.;	
			Red. O2	Habitat reduction/mortality	
			Ind. Temp.	Change vital rates, shifts distrib. Decr. calc. leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
Tail of the Bank 1	c. 2,000 m	Higher sponge and coral (small gorgonian) concentration. Also erect bryozoans, large sea squirts (*Boltenia ovifera*) crinoids and cerianthids	Dec. pH	Benthic calcifiers: lower growth and dec. shell length Corals/Sponges: Decr. calc. rates and food availability; Change in reproduction	
			Red. O2	Benhos: incr. mortality; change in spp. composition and distribution Corals/Sponges: Habitat reduction/mortality	
			Ind. Temp.	Benthos: N shift in distrib.; mass mortality events in sessile spp.; shifts to deeper depths; change in vital rates; increased disease	

Area	Depth*	Taxa	Parameter	Climate Change Impact	1st Impacts
				Corals/Sponges: changes in vital rates, shifts in distribution. Decr. in calcif. often leading to mortality	
			Red. POC flux	Benthos, Corals/Sponges: Decreased productivity	
			Red. AMOC	Benthos: introduction of warm water spp. Sponges/Corals: ?	
Flemish Pass/E Canyon 2	Depths <150 m	Area of higher sponge and coral concentration: Sponge, large gorgonians and sea pens VMEs	Dec. pH	Decr. calc. rates and food availab.; Change in reprod.;	
			Red. O2	Habitat reduction/mortality	
			Inc. Temp.	Change vital rates, shifts distrib. Decr. calc. leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
Beothuk Knoll 3	?	Area of higher sponge and coral concentration: Sponge VMEs	Dec. pH	Decr. calc. rates and food availab.; Change in reprod.;	
			Red. O2	Habitat reduction/mortality	
			Ind. Temp.	Change vital rates, shifts distrib. Decr. calc. leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
Beothuk Knoll 13		Area of high sponge and coral concentrations: Large sponges and large gorgonian coral VMEs	Dec. pH	Decr. calc. rates and food availab.; Change in reprod.;	
			Red. O2	Habitat reduction/mortality	
			Ind. Temp.	Change vital rates, shifts distrib. Decr. calc. leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
Eastern Flemish Cap 4		Sponges, large gorgonians, cerianthids VMEs	Dec. pH	Decr. calc. rates and food availab.; Change in reprod.;	
			Red. O2	Habitat reduction/mortality	
			Ind. Temp.	Change vital rates, shifts distrib. Decr. calc. leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
NorthEast Flemish Cap 5	c. 1,300 m – 2,450m	Sponge, crinoids, gorgonian corals VMEs	Dec. pH	Decr. calc. rates and food availab.; Change in reprod.;	
			Red. O2	Habitat reduction/mortality	
			Ind. Temp.	Change vital rates, shifts distrib. Decr. calc. leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
Sackville Spur 6	900-2,000m	Demosponges Geodiids (*Geodia barretti*), *Stelletta normani* and *Stryphnus ponderosus*. High diversity/ abundance of megafaunal spp.	Dec. pH	Decr. calc. rates and food availab.; Change in reprod.;	
			Red. O2	Habitat reduction/mortality	
			Ind. Temp.	Change vital rates, shifts distrib. Decr. calc. leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
N Flemish Cap 7, 8, 9; NW Flemish Cap 10, 11, 12; E Flemish Cap 14	<150m-1200m	Seapens (and associated crinoids, cerianthids, black corals)	Dec. pH	Decr. calc. rates and food availab.; Change in reprod.;	
			Red. O2	Habitat reduction/mortality	
			Inc. Temp.	Change vital rates, shifts distrib. Decr. calc. leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	

Table VI.4. Expected effects of climate change on the main elements of NEAFC VMEs

Area	Depth*	Taxa	Parameter	Climate Change Impact	1st Impacts
Northern MAR Area	2000 m and shallower	Cold water corals	Dec. pH	Decrease in calcification rates and food availability; Change in reproduction;	
			Red. O2	Habitat reduction/mortality	
			Inc. Temp.	Changes in vital rates, shifts in distribution. Decr. calc. often leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
Middle MAR Area		Cold water corals	Dec. pH	Decrease in calcification rates and food availability; Change in reproduction;	
			Red. O2	Habitat reduction/mortality	
			Inc. Temp.	Changes in vital rates, shifts in distribution. Decr. calc. often leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
Southern MAR Area		Cold water corals	Dec. pH	Decrease in calcification rates and food availability; Change in reproduction;	
			Red. O2	Habitat reduction/mortality	
			Inc. Temp.	Changes in vital rates, shifts in distribution. Decr. calc. often leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
Altair Seamount		Corals; fish	Dec. pH	Corals: Decr. calc. rates and food availab.; Change in reprod.; Fish: reduced ability to settle and avoid predators	
			Red. O2	Corals: Hab. red./mortality Fish: Decr. hab., red. growth & thermal toler.: change in vital rates depend. prey availability	
			Inc. Temp.	Corals: changes in vital rates, shifts in distribution. Decr. calc. often leading to mortality Fish: latitudinal & depth adaptations; changes vital rates	
			Red. POC flux	Corals: Decreased productivity Fish: changes in vital rates dependent on prey response;	
			Red. AMOC	Corals: ? Fish: change in migration, introduction of warm water spp	
Antialtair Seamount		No biological info	Dec. pH	?	
			Red. O2	?	
			Inc. Temp.	?	
			Red. POC flux	?	
			Red. AMOC	?	
Hatton Bank	<500 - >1,000m	rich diversity of epifauna, including scleractinian corals, stylasterids ('lace' corals), antipatharians ('black' corals), soft corals, cup corals and gorgonian sea fans; sponges, including glass sponges; sessile sea cucumbers;	Dec. pH	Benthic calcifiers: lower growth and decrease in shell length Corals/Sponges: Decreases in calcification rates; Change in reprod.; Decr. food availability	
			Red. O2	Benthos: incr. mortality; change in spp. composition & distrib. Corals/Sponges: Habitat reduction/mortality	
			Inc. Temp.	Benthos: N shift in distrib.; mass mortality events in sessile spp.; shifts to deeper depths; change in vital rates; increased disease Corals/Sponges: changes in vital rates, shifts in distribution. Decrease in calcification often leading to mortality	

Area	Depth*	Taxa	Parameter	Climate Change Impact	1st Impacts
		anemones and brachiopods. elaborate cold water coral reefs	Red. POC flux	Benthos, Corals/Sponges: Decreased productivity	
			Red. AMOC	Benthos: introduction of warm water spp. Sponges/Corals: ?	
Rockall bank	65m-220m	Coldwater corals (incl. *Lophelia pertusa*) and sponges	Dec. pH	Decr. calc. rates and food availability; Change in reprod.;	
			Red. O2	Habitat reduction/mortality	
			Inc. Temp.	Chang. vital rates, shifts distrib. Decr. calc. leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
Logachev Mounds	500-1200m	Living cold water corals (incl. *Lophelia pertusa* and *Madrepora oculata*)	Dec. pH	Decr. calc. rates & food availab.; Change in reproduction;	
			Red. O2	Habitat reduction/mortality	
			Inc. Temp.	Chang. vital rates, shifts in distrib. Decr. calc. lead mortal.	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
West Rockall Mounds	?	Living cold water corals (incl. *Lophelia pertusa* and *Madrepora oculata*)	Dec. pH	Decr. calcif. rates and food availab.; Change in reprod.;	
			Red. O2	Habitat reduction/mortality	
			Inc. Temp.	Changes in vital rates, shifts in distribution. Decr. calc. often leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
Edora's Bank		Gorgonian corals, soft & cup corals, coldwater reef building corals; sponges	Dec. pH	Decr. calc. rates and food availab.; Change in reprod.;	
			Red. O2	Habitat reduction/mortality	
			Inc. Temp.	Change vital rates, shifts distrib. Decr. calc. leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
Southwest Rockall Bank	65-220m	stony corals, sponges, sea pens, and the occasional black coral	Dec. pH	Decr. calc. rates and food availab.; Change in reprod.;	
			Red. O2	Habitat reduction/mortality	
			Inc. Temp.	Change vital rates, shifts distrib. Decr. calc. leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
Hatton-Rockall Basin	>1,000m	Sponges	Dec. pH	Decr. calc. rates and food availab.; Change in reprod.;	
			Red. O2	Habitat reduction/mortality	
			Inc. Temp.	Change vital rates, shifts distrib. Decr. calc. leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	
Hatton Bank 2		coldwater corals (incl. *Lophelia pertusa*) and sponges	Dec. pH	Decr. calc. rates and food availab.; Change in reprod.;	
			Red. O2	Habitat reduction/mortality	
			Inc. Temp.	Change vital rates, shifts distrib. Decr. calc. leading to mortality	
			Red. POC flux	Decreased productivity	
			Red. AMOC	?	

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